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PEAR GROWING IN CALIFORNIA

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LUTHER D. DAVIS[1] AND WARREN P. TUFTS[2]

INTRODUCTION

THE PEAR was brought to America by the first French and English colonists. The earliest authentic record is probably that of the Endicott pear tree planted near Salem, Massachusetts, about 1630. In Europe the pear has long been popular, grown as commonly as the apple, if not more so. In America, however, despite its early introduction and its popularity, it has never become as widely grown as the apple. Its commercial production is restricted to a few favored places, probably because of such factors as climate, pests, diseases, and trade difficulties.

The introduction of pears into California is attributed to the Franciscans, who, led by Father Junipero Serra, planted pear seeds carried from the Old World. As early as 1792, fine orchards of apples, pears, figs, and other fruits were thriving at Mission Santa Clara; and a visitor noted several hundred bearing pear trees at Mission San Jose. Fortunately, the pear can withstand considerable abuse and so survived in these mission gardens long after the padres had ceased caring for them; even today we may find bearing trees in some of the old mission orchards.

Seeds of commercial pears were planted in the early days of mining in the Sierra foothills of the Sacramento and San Joaquin valleys, and a few oriental pears were set out by the Chinese immigrants. Later, grafting wood and grafted trees of many varieties, brought from the missions, from eastern states, and even from Europe, were grown to supply fruit to miners and other new settlers. With the discovery of gold, certain enterprising young men who had come in search of the precious ore found that more money could be made by supplying fruit for the satisfaction of the prodigal miners, than by panning gold; and pear growing gained impetus. According to Wickson, the Bartlett was brought around the Horn in 1850 and planted in the Napa Valley.

Though a few of these early commercial orchards were planted in the interior valleys, the more extensive plantings were at first in the Santa Clara Valley. History is replete with accounts of the high price paid for these early-day pears.

With the entrance of the transcontinental railroad in 1869 the fruit industry began expanding rapidly, and today pears are an important commercial crop.

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WORLD DISTRIBUTION AND TRENDS[3, 4]

In tonnage produced, pears are the third most important tree fruit grown in the world and the fourth most important among all fruits for which production statistics are available. World pear production for the period 1932–1936 averaged approximately 4 million short tons a year or approximately 6 per cent of the estimated world production of all fruits for all uses of about 65 million tons, fresh weight. Of this total, grapes comprised about 52 per cent, apples 15 per cent, oranges 11 per cent, pears 6 per cent, plums 5 per cent, bananas 3 per cent, and all other fruits 8 per cent.

Pear production is confined chiefly to countries in the temperate zones. France produces the most pears, followed in rank by the United States and Germany. However, much of the crop of France, Germany, and other central European countries is used for pear cider or perry. The United States is the outstanding producer of dessert or table pears and of canned and dried pears (table 1). Probably not over one third of the world production of pears can be classified as of dessert quality and about one half of such fruit is produced in the United States.

Like the United States, the British dominions of Australia, New Zealand, and South Africa, and also Argentina, produce pears almost entirely for dessert and cooking. Pear production in these southern-hemisphere countries, with a harvest season the opposite of California, has been increasing rapidly since 1930 and during recent years their fresh exports have very largely dominated the world's best export market, the United Kingdom, during the late winter and spring—February through June.

Eastern Production.—Except in a few states on the Great Lakes, pear growing outside of the Pacific Coast is of little commercial importance, most of the fruit being produced in farm-home orchards and largely consumed locally (fig. 1, and table 1). According to the 1935 Census the average number of trees reported per farm growing pears on the Pacific Coast was 136, as compared with only about 9 trees in other states. The Kieffer is the variety most generally grown in the East. Although of inferior quality, this variety produces attractive looking fruit that keeps

[3] The section on the economic status of the pear industry was contributed and tables 1 and 2 were compiled by S. W. Shear, Associate Agricultural Economist in the Experiment Station and Associate Agricultural Economist on the Giannini Foundation.

[4] Discussion of world distribution and trends in pear production is based upon:
Edwards, A. C., and S. I. Katz. World fresh fruit production. U. S. Dept. Agr. Bur. Agr. Econ. August, 1938. (Mimeo.)
Great Britain Imperial Economic Committee. Apples and pears. London, 1938.
Shear, S. W., and Donald Larimore. Trends in United Kingdom imports of fresh pears. Blue Anchor 26(5):14, 15, 29, 30. May, 1939.

well, while the tree is better adapted to a wider variety of natural conditions than other varieties and is hardier and more blight-resistant.

Michigan and New York, the two most important commercial pear-producing states in the East, and possibly Pennsylvania, are the only

TABLE 1

UNITED STATES PRODUCTION, IN TONS,* OF HARVESTED AND UNHARVESTED PEARS; AVERAGES FOR 1919–1938, AND ANNUALLY FOR 1929–1939

Year	United States	Pacific Coast				New York	Michigan	All other states
		Total	California	Oregon	Washington			
	1	2	3	4	5	6	7	8
Averages:								
1919–1923..	403,370	196,560	118,200	27,470	50,890	53,280	13,160	140,370
1924–1928..	523,060	308,850	185,000	55,140	68,710	43,150	14,600	156,460
1929–1933..	597,500	402,080	229,000	70,170	102,910	33,870	19,160	142,390
1934–1938..	700,070	452,340	228,400	87,800	136,140	34,850	32,970	179,910
Annual:								
1929.....	532,090	344,810	190,000	71,750	83,060	18,400	10,000	158,880
1930.....	664,100	475,500	273,000	85,000	117,500	50,050	21,100	117,450
1931.....	616,980	362,860	217,000	50,000	95,860	21,850	17,220	215,050
1932.....	595,420	418,900	244,000	73,600	101,300	49,800	27,180	99,540
1933.....	578,920	408,320	221,000	70,470	116,850	29,250	20,300	121,050
1934.....	676,180	411,860	233,000	65,660	113,200	36,080	31,150	197,090
1935.....	625,670	377,370	163,000	84,370	130,000	25,750	29,150	193,400
1936.....	669,100	469,000	240,000	94,000	135,000	30,780	34,750	134,570
1937.....	729,350	452,750	224,000	88,750	140,000	32,620	34,500	209,480
1938.....	800,040	550,720	282,000	106,220	162,500	49,000	35,280	165,040
1939†.....	762,400	498,200	248,000	105,720	144,480	43,720	33,850	186,630

* Bushels converted to tons at 48 pounds per bushel for California and 50 pounds per bushel for all other states and given to the nearest 1,000 tons for California and to the nearest 10 tons for all other states.

† Preliminary data, subject to revision.

Sources of data:

Cols. 1–5: United States Department of Agriculture Crop Reporting Board. General crop report: December, 1939. p. 40, 84. December 19, 1939. (Mimeo.)

Cols. 6, 7, and 8:

1919–1935: United States Bureau of Agricultural Economics. Revised production of apples, peaches, pears, grapes, and cherries, 1919–1935. p. 10–12. June 28, 1937. (Mimeo.)

1936–1939: United States Bureau of Agricultural Economics. United States Crop Reports, monthly issues. (Mimeo.)

eastern states in which the Bartlett acreage exceeded that of Kieffers in 1938.

Ravages of insect pests and diseases, particularly of fire blight (also commonly called pear blight) and of psylla are the two chief reasons why the number of pear trees in states outside of the Pacific Coast decreased about one half from 1910 to 1930. From 1930 to 1935 the downward trend continued more slowly, with acreage declining about 5 per cent. Production has not declined so rapidly as acreage during the past thirty years, apparently because the lower-yielding neglected home or-

chards have been the ones most generally eliminated. Yields and production of eastern pears during the period 1940–1945 may continue to average about as high as during the preceding five years; but any expansion of acreage will continue to be discouraged by low prices and also by insect pests and diseases, particularly fire blight, until economically effective measures for controlling that disease have been devised.

Pacific Coast Production.—Nearly all of the expansion of United States pear production since 1919 has taken place in the three Pacific Coast states of California, Oregon, and Washington, where conditions favorable to economical production of large yields of good-quality fruit

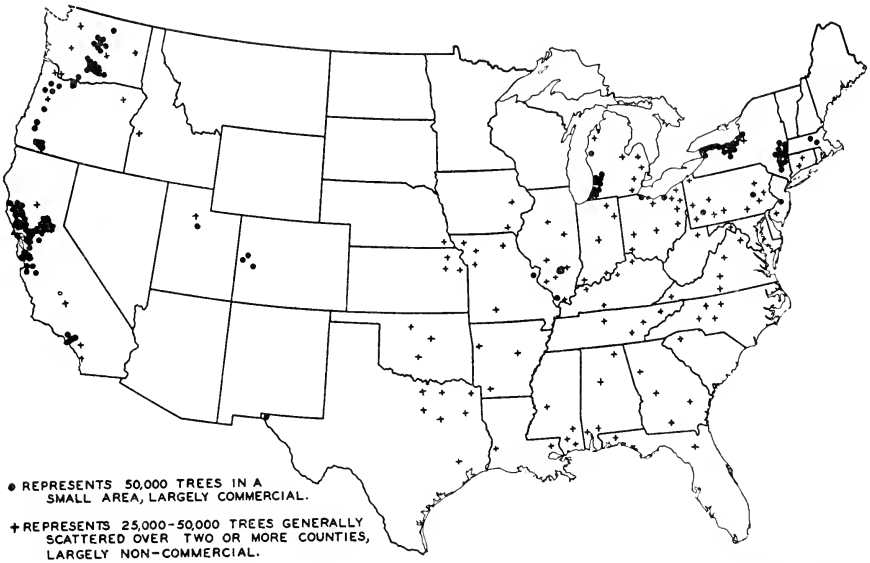

Fig. 1.—Distribution of commercial and noncommercial plantings of pear trees in the United States, as given in the 1935 Census.

have resulted in the rapid growth of the most highly commercialized pear-producing section in the world (fig. 1). Total production in these states increased from an average of about 195,000 tons during 1919–1923 to over 450,000 tons during 1934–1938, while production in other states as a whole increased only slightly. The relatively high yields per acre on the Pacific Coast are shown by the fact that the 65 per cent of the country's pear crop contributed by this section during 1934–1938 was produced on only about 50 per cent of the bearing trees.

Commercial pear production on the Pacific Coast is very largely concentrated in about nine districts. The more important of these districts, going roughly from north to south on the map in figure 1, are the Wenatchee and Yakima Valley districts in central Washington; the Hood River Valley in north-central Oregon and the Rogue River Valley around Med-

ford in southern Oregon. In California, the districts are: the foothill district of El Dorado, Placer, and Nevada counties; the Sacramento River district; the coast district north of San Francisco Bay, and that south of the Bay generally known as the Santa Clara Valley district; and the southern California acreage, mostly in the Antelope Valley in Los Angeles County, which is of minor and decreasing commercial importance. Data for pear production in California are given in table 2.

On the Pacific Coast the Kieffer is not grown at all commercially, the Bartlett being by far the most important variety. During the years 1934–1938, Bartletts averaged between 70 and 75 per cent of the Pacific Coast pear crop. In California this variety accounted for nearly 88 per cent of the total crop, in Washington slightly over 70 per cent, and in Oregon approximately 40 per cent. The Bartlett is an all-purpose pear, being utilized extensively for fresh shipment and for canning and drying. It has been practically the only variety canned and dried commercially on the Pacific Coast. Of the 320,000-ton average Bartlett crop harvested on the Pacific Coast during the years 1934–1938, about 47 per cent was canned and 10 per cent dried. The balance of about 43 per cent was mostly shipped fresh except that some low-grade fruit was wasted. During the same period all of the tonnage of dried pears came from California, which used about 32,000 tons of fresh Bartletts for this purpose; or approximately 17 per cent of the state harvested production of the variety.

Of an average of approximately 150,000 tons of Bartletts canned on the Pacific Coast during the years 1934–1938, about 44 per cent was produced in California, 43 per cent in Washington, and 13 per cent in Oregon. The quantity of Bartletts canned on the Pacific Coast has increased tremendously since the World War, rising from an average of about 45,000 tons during 1919–1923 to approximately 150,000 tons during 1934–1938. Expansion has been the greatest in the Pacific Northwest which contributed only about 30 per cent of the Coast tonnage canned during 1919–1923 and 56 per cent during 1934–1938. The rapid increase in the canned pack of fruit salad and fruit cocktail has absorbed a substantial part of the Bartletts canned in California in recent years. Approximately 45 per cent of the annual average of 65,000 tons canned in California during 1934–1938 is estimated to have been so used.

Only about 34 per cent of the California harvested crop of Bartletts was canned during the period 1934–1938 as compared with about 57 per cent for Oregon and approximately 66 per cent for Washington. The proportion of the California Bartlett crop canned has decreased since 1920 largely because of increased production of canning Bartletts in the Pacific Northwest. Many of the Bartletts produced in Oregon, and more

TABLE 2

CALIFORNIA TOTAL BEARING AND NONBEARING ACREAGE OF PEARS BY VARIETY AND BY COUNTY AND DISTRICT, 1936*

County and district	All varieties	Bartlett	All varieties except Bartlett						
			Total	Hardy	Winter Nelis	Bosc	Comice	Anjou	Other varieties
State total	59,540	49,848	9,692	2,773	1,812	1,333	935	581	2,258
District totals:									
Coast north of Bay	15,748	15,433	315	40	24	165	4	31	51
Coast south of Bay	15,381	9,545	5,836	2,422	1,111	453	799	295	756
Sierra Mountain	12,496	10,672	1,824	163	420	599	96	191	355
Sacramento Valley	12,139	10,984	1,155	147	99	29	10	3	867
Southern California	2,411	2,051	360	—†	128	47	12	47	126
San Joaquin Valley	1,365	1,163	202	1	30	40	14	14	103
Coast north of Bay:									
Lake	5,302	5,268	34	0	11	16	1	6	—
Mendocino	4,229	4,059	170	39	2	85	2	25	17
Sonoma	3,763	3,691	72	1	6	54	0	—	11
Napa	2,196	2,170	26	0	2	10	0	0	14
Other counties‡	258	245	13	0	3	0	1	—	9
Central coast south of Bay:									
Santa Clara	7,436	4,699	2,737	1,353	373	257	378	114	262
Contra Costa	2,790	2,603	187	122	5	10	32	0	18
Santa Cruz	1,555	582	973	575	40	48	138	56	116
San Benito	1,388	476	912	176	332	71	113	91	129
Monterey	1,004	139	865	149	339	53	113	31	180
San Luis Obispo	597	576	21	2	12	4	3	0	—
Other counties‡	611	470	141	45	10	10	22	3	51
Sierra Mountain:									
Placer	6,648	5,676	972	128	300	139	60	46	299
El Dorado	4,395	3,765	630	30	66	444	1	79	10
Nevada	1,161	1,026	135	5	13	15	33	64	5
Other counties‡	292	205	87	0	41	1	2	2	41
Sacramento Valley:									
Sacramento	5,608	5,370	238	59	70	25	4	2	78
Solano	3,735	3,196	539	40	1	0	5	0	493
Yuba	906	857	49	36	7	0	0	0	6
Yolo	654	636	18	—	1	4	0	0	13
Other counties‡	1,236	925	311	12	20	0	1	1	277
Southern California:									
Los Angeles	1,688	1,563	125	—	36	—	2	38	49
Other counties‡	723	488	235	—	92	47	10	9	77
San Joaquin Valley:									
San Joaquin	693	566	127	1	20	40	12	13	41
Kern	479	453	26	0	—	0	—	1	25
Other counties‡	193	144	49	0	10	0	2	—	37

* To avoid using fractions of acres as reported, the acreage for each variety is given to the nearest acre for county and district totals. "Other varieties" is computed by subtracting the total of the individual varieties listed from the total of all varieties except Bartlett. "Other counties" is computed by subtracting the total of the individual counties listed for a given district from the district total.

† Dashes indicate less than 0.5 of an acre.

‡ "Other counties" include the following: Coast north of Bay—Humboldt and Marin, central east south of Bay—Alameda, and San Mateo; Sierra Mountain—Trinity, Siskiyou, Shasta, Modoc, Lassen, Amador, Calaveras, Mariposa, Alpine, Tuolumne, and Mono; Sacramento Valley—Tehama, Glenn, Colusa, Sutter, and Butte; Southern California—Santa Barbara, Ventura, San Bernardino, Orange, Riverside, San Diego, and Imperial; and San Joaquin Valley—Stanislaus, Merced, Madera, Fresno, Kings, and Tulare.

Source of data:

Blair, R. E., W. R. Schreiber, and C. N. Guellow. California fruit and nut acreage survey, 1936. U. S. Agr. Adjustment Admin. Statistical Publication 1:94-101. Tables 86-93. January, 1938.

particularly in Washington, are, like those of the Santa Clara Valley, of a character better adapted to canning than to fresh shipment. The two largest and most specialized canning Bartlett districts are the Yakima Valley in Washington and the Santa Clara Valley in California. The Yakima Valley in Washington, the largest canning-Bartlett-producing district on the Pacific Coast, and the smaller districts of Wenatchee in Washington and Hood River in Oregon, canned a large majority of their Bartletts during the period 1934–1938. The Santa Clara Valley is the only large Bartlett-producing district in California which utilizes nearly all its Bartletts for canning. Only a relatively small proportion of the Bartlett crop of other districts in California has usually been canned—about 25 per cent being the maximum amount of its Bartletts that any other one district of the state has used for canning.

During 1934–1938, one half of California Bartletts were shipped fresh, the large majority going to out-of-state markets. The state ships a much larger proportion of its Bartletts fresh than Oregon and Washington and cans correspondingly less, chiefly because much of its crop is of good shipping quality and about half of it matures and is shipped before Bartletts from other states are on the domestic market. Moreover, Califorina Bartletts usually command a substantial premium over Northwest Bartletts in eastern markets, which makes the canning-pear market relatively more attractive to Northwest, than to California, growers. The Rogue River Valley of Oregon, the most important fresh-Bartlett-shipping district in the Northwest, shipped about half of its Bartletts during the five years, 1935–1939. Aside from the Santa Clara Valley, all important Bartlett-producing sections in California usually ship a large majority of these pears to the fresh market. The chief fresh-Bartlett-shipping districts in California are the Sacramento River district, Contra Costa and Solano counties, Mendocino and Lake counties, and El Dorado and Placer counties; but each of these usually sells at least a small part of its crop for canning.

While California dominates shipments of fresh Bartletts on the Pacific Coast, Oregon and Washington lead in shipments of other varieties of pears, the so-called "fall and winter shipping" varieties, the production of which has increased at a much more rapid rate than Bartletts since 1919. Pacific Coast total production of pears other than Bartletts during 1934–1938 averaged about 120,000 tons as compared with approximately 330,000 tons of Bartletts. Of this total of late pears, Oregon and Washington produced about 77 per cent and California the balance of 23 per cent. During the years 1934–1938 varieties other than Bartletts constituted 12 per cent of the pear crop in California and about 40 per cent in the Northwest.

Varieties of pears other than Bartletts, which are practically all shipped fresh, mostly mature later than Bartletts and hence are generally spoken of as fall and winter varieties or simply as late pears. There are, however, several varieties of pears earlier than Bartletts of some minor importance. The Hardy is a midseason variety, which has ranked next to Bartletts in California.[5] The early varieties of pears grown in California to a significant, but limited, extent are the Comet (Lawson), Wilder, Clapp, and Early Bartlett. The chief varieties of the late pears grown on the Pacific Coast, in the order of their importance according to the acreage in 1936 are Anjou (36.3 per cent), Bosc (21.4 per cent), Winter Nelis (16.2 per cent), Hardy (8.6 per cent), and Comice (5.5 per cent). Of minor, and mostly of declining importance are Clairgeau, Easter, Glou Morceau, P. Barry and Forelle, grown in California, and the Flemish Beauty grown to a limited extent in Washington.

Commercial production of the better late dessert varieties in eastern United States is very scattered and estimated not to exceed 5 per cent of the United States total of such varieties.[6] Their influence on the market for Pacific Coast pears is, therefore, of almost no practical significance.

Outlook Summary.—High prices for fruit during and after the World War led the Pacific Coast bearing acreage and the United States production of pears approximately to double from 1919 to 1939. The great increase in production of pears, as well as of all fruits as a whole, together with the marked reduction in the level of consumer income and demand after 1929, resulted in such a great decline in farm prices of pears that California growers could purchase only about half as much with the average price of a ton of pears during 1930–1938 as during 1921–1925. California farm prices dropped from about $50 a ton during 1921–1925 to an average of about $20 a ton during 1930–1938—a relatively greater decline than occurred in the prices of things which farmers buy. A considerable tonnage was also of no value, being wasted or unharvested, during some of the years of low prices. The decline in prices was greatest for late varieties of pears which, until 1929, returned growers substantially more per ton than Bartletts.

Even before the European war recently curtailed our export market for pears and other fruits, prospects were for continued low prices for California pears during 1940–1945, similar in purchasing power to that prevailing during 1934–1938. It then seemed unlikely that consumer in-

[5] Braun, E. W., and H. H. Stippler. Economic statement relating to the marketing of Beurre Hardy pears grown in California. U. S. Dept. Agr. Agricultural Adjustment Administration. 19 p. February, 1939. (Typewritten.)

[6] Stippler, H. H. Economic statement relating to the marketing of Pacific Coast fall and winter pears. U. S. Dept. Agr. Agricultural Adjustment Administration. 44 p. August, 1938. (Mimeo.)

comes would increase enough to improve domestic demand sufficiently to more than offset the increase in Pacific Coast pear production expected because of the greater productivity of acreage already planted. It now seems that drastic curtailment of exports of pears and of other fruits to Europe for the duration of the present war, at least, is likely to decrease the demand for most of our pears by more than any increase in domestic demand that the war may bring about by stimulating certain of our industries and thereby increasing consumer income in the United States. However, any substantial changes in the monetary situation of the world that may occur during and after the war, such as inflation, might greatly affect the real income of Pacific Coast pear growers by changing the relation of the price growers receive for pears to their production costs and living expenses. Reduction in acreage to bring production into balance with a lower level of demand than prevailed during 1934–1938 for pears and other tree fruits, would probably be a painful economic process brought about only slowly by several consecutive years of very low prices, unless disease (for example fire blight), or other natural casualties should take sudden and severe toll of the industry.

How greatly drastic curtailment of our European exports might reduce the market for our pears is partly indicated by the facts that about 20 per cent of the national pear crop was exported during 1934–1938, and that approximately 86 per cent of this was shipped to Europe. During this period approximately 14 per cent of United States fresh pear shipments were exported, 30 per cent of the canned pear pack, and 76 per cent of the dried.

Curtailment of exports of pears, however, affects the Pacific Coast and California to a greater extent and more directly than United States totals indicate, as a very large majority of the exports are from the Pacific Coast. All of the dried-pear exports have been from California and considerably more than 90 per cent of the canned-pear exports have been from the Pacific Coast. A large majority of fresh-pear exports have been fall and winter pears, the commercial production of which is largely concentrated on the Pacific Coast; about 46 per cent of the shipments of these pears were exported during 1934–1938.[7] However, the proportion of the different varieties exported has differed considerably. The Hardy pear industry will probably suffer most directly and most severely from curtailment of exports because about 90 per cent of this variety has been exported, mostly to the United Kingdom, and because it is marketed chiefly in August and September when competition with the popular Bartlett is very great in the domestic market.

[7] Stippler, H. H. Shipments and distribution of Pacific Coast fall and winter pears, 1934–1938. General Crops Section, Division of Marketing and Marketing Agreements, U. S. Dept. Agr. April, 1940. 10 p. (Mimeo.)

CHOOSING A LOCATION FOR PEARS

The tree and fruit of the pear, the productivity and life span of the tree, and the quality of the fruit, are all affected by environment. Although California is especially fortunate in having large areas where the pear does as well as anywhere in the United States, pear-growing districts vary widely in the type of fruit produced. There is as much as 2–2½ months' difference in the maturity of the Bartlett in the earliest and latest districts. Where well grown the Bosc is a delightful yellow, well-russeted fruit when mature; but in other areas the russet may be almost lacking. Many similar instances illustrate the responsiveness of the pear to its growing conditions.

Pears are produced in sizable commercial quantities in many counties of the state; fourteen counties have more than 1,000 acres each. As the industry is an old one, much information has been acquired regarding the response of the pear in the various districts. Information regarding its success and limitations can be secured from farm advisors, agricultural commissioners, and growers. A prospective investor in pear production should first acquaint himself with the characteristics of a particular area. The person who does not expect to grow the fruit for profit can labor with handicaps not allowed to the commercial grower, although his personal satisfaction may be less than under more nearly ideal conditions.

In considering a location for pear growing, certain factors should be considered: (1) climate; (2) water supply; (3) soil, and (4) transportation and packing facilities.

Climate.—In selecting a site for pears or in choosing varieties, one should consider the following climatic conditions: (1) winter weather (enough cold days to break the rest period and thus prevent injurious delayed foliation); (2) weather conditions during the blooming period; (3) conditions affecting the quality of the fruit, and (4) conditions in relation to disease. Besides these four points the commercial grower of Bartlett pears in California should consider a fifth—namely, time of maturity.

Winters that are too warm cause uneven opening of the blossoms, cause many flowers to die in the buds before they open, and many leaf buds to remain dormant throughout the summer. Death of the flowers in the bud, and failure of many leaf buds to open will result in reduction of yield. The blossoms may open unevenly, an irregularity that may cause loss in at least three ways: (1) The difficulty of properly timing the calyx spray for codling moth is increased because some blossoms are open and ready long before others. (2) The cost of blight control may be

increased because the time for blossom infection is lengthened. (3) Cross-pollination may be rendered less effective in districts where it is needed. In comparison with such varieties as the Winter Nelis, the Bartlett requires more chilling. In the Northwest, where the rest has been completely broken, it will bloom earlier than they. In the Sacramento Valley, after the coldest or foggiest winters, it may bloom at the same time as the Winter Nelis, but after the warmest winters its blossoming may not begin till after the Winter Nelis is completed (fig. 2).

Fig. 2.—At the left are Winter Nelis pear trees almost in full leaf, blossoms fallen; at the right is a row of Bartlett trees with buds just opening. The photograph was taken at Davis in the spring of 1935, after an especially warm winter. (From Bul. 611.)

In the Sacramento, Santa Clara, and Antelope valleys lack of winter chilling seems rarely, if ever, to cause reduced growth or yield. This is also usually true of the fog-free foothill districts around the Sacramento Valley. In some years, however, in these areas above the fog line where the buds have warmed up each day, a considerable number of flowers have died in the bud.

In California the weather during blossoming and shortly afterward is very important. Practically all the loss from low temperature occurs during this period. Since the pear blooms relatively late, it is in less danger than almonds or apricots; but locations of extreme late frosts should nevertheless be avoided. Artificial heating of pear orchards is an uncommon practice, economically questionable. Fogs during blossom-

ing may hinder cross-pollination. High humidities during blossom will greatly increase the hazard of loss from blight.

The pear will withstand higher summer temperatures than the apple; in fact, the Bartlett seems to attain its highest quality under relatively high summer temperatures. Bartletts grown in the cooler areas tend to ripen unevenly; the tissue at the core breaks down before the outside is ready for use. Consequently, Bartletts from the warmer sections tend to be shipped for eating fresh; those from the cooler sections to be canned. Not all varieties, however, will succeed in the hot valleys.

Weather conditions are important also in relation to disease. This is especially true of fire blight, which is most prevalent under conditions of high humidity and high temperature and has greatly limited pear growing in the United States, and likewise in California. Large areas in the upper Sacramento and San Joaquin valleys, once planted to pear orchards, are now nearly devoid of pear trees because of the virulence of this disease. The Santa Clara Valley is remarkably free; seldom does this disease work any great damage there. Fire blight is equally important to the amateur and the commercial grower

The commercial grower of Bartlett pears should consider the season of maturity. A large part of the crop is shipped East, where it must compete with fruits from other sections—especially with plums, fresh peaches, and melons from the South during midseason and with pears from other areas later on.

Water Supply.—Pear trees in California will continue to live and produce crops under conditions of normal rainfall, but, except in most favored districts, irrigation is desirable. The fruit does not size well unless the trees have available water throughout the season. Although pears will tolerate either drought or excessive moisture for long periods, one can obtain bigger crops and better fruit by attending to moisture requirements. The marginal orchard suffers first from overproduction or underconsumption; the availability of water may mean the difference between profit and loss.

Soil.—The best soil for the pear is probably one that approaches the ideal fruit soil—deep, fertile, well-drained, easily worked, not too heavy, and free from alkali. Pears are more tolerant, however, of deviations from this ideal than are most deciduous fruits. Pear trees are growing well on the heavy soils of the Santa Clara Valley, on the delta areas of the Sacramento River, and in the foothills of the Sacramento Valley. On French rootstock they are reasonably tolerant of a high water table. Trees growing behind the levee of the Sacramento River experience, each winter, a water table within 2 or 3 feet of the surface and occasionally have stood in water for many days. Although, under such extreme con-

ditions, they have undoubtedly suffered, they have nevertheless produced crops following the treatment. This example illustrates the tolerance of the pear toward unfavorable conditions, but is not a guide for a choice of locations.

Transportation and Packing Facilities.—Much of the crop in California is sold as fresh fruit. As pears are usually washed, graded, packed, and loaded from a special packing-house, the orchard should be located near such a house. Distance means expensive additional hauling, extra jolting of the fruit, and extra delay before the ripening processes can be slowed down by cooling.

CHOICE OF VARIETIES FOR THE ORCHARD[8, 9]

Pears probably exhibit greater diversity in size, shape, and texture than do any other of the hardy fruits. This is especially true among the species, which vary from the small, hard, inedible fruits of the oriental *Pyrus Calleryana* to the fine, large, delicious fruit of some varieties of the common European *P. communis*. Certainly our cultivated varieties exhibit more individuality than any other deciduous fruits. Perhaps it is for this reason that the pear is a favorite with the amateur gardener and plant breeder.

Historically, the pear is very old. It was grown by the Romans even before the Christian era, though from all accounts it was highly dissimilar to the fruit we relish today. The ancients had curious ideas about it, regarding it as a medicine as well as a food. It evolved very slowly until its introduction and cultivation in Belgium, where it found favorable soils and climate, and, what is equally important, men who were interested in breeding and cultivating it. The first new varieties were introduced by Abbé Hardenpont, about 1758, thirty years after he had first planted the seeds. The ensuing hundred years witnessed a greater development than in all the centuries before. Many hundreds of thousands of seedlings were grown, and many hundreds of varieties introduced. Van Mons, a physician of Belgium who produced many splendid varieties, at one time had 80,000 seedlings in his nursery.

All the important pear varieties growing in the United States belong to the European species, *Pyrus communis,* except a very few hybrids such as the Kieffer, Le Conte, and Garber, which are crosses between the European type and the Japanese pears, *Pyrus serotina.*

Despite the large number of pear varieties (*The Pears of New York* lists nearly a hundred major and more than 2,500 minor varieties), com-

[8] New York State Department of Agriculture. The pears of New York. In: Twenty-ninth annual report. vol. 2, part II. 636 p. 1921.

[9] Weldon, George P. Pear growing in California. California State Comm. Hort. Mo. Bul. 7:219–410. 1918.

Fig. 3.—Anjou. The stems are short and thick, and the fruit greenish, sprinkled with russet, sometimes with full crimson. The flesh is white, melting, juicy, and of finest flavor. Sizes run from 100's to 180's in standard boxes and from 40's to 60's in half-boxes. (Courtesy, California Fruit Exchange.)

mercial production is limited to a few—in California to about fifteen—with most of the acreage confined to six. Of the 54,007 acres of pears here in 1939,[10] 45,369 were devoted to Bartlett, 2,829 to Hardy, 1,552 to Winter Nelis, 1,186 to Bosc, 958 to Comice, 507 to Anjou, and 1,606 to other varieties. The latter acreage consists of Madeleine, Comet, Wilder, Clapp, Early Bartlett, Howell, Clairgeau, Seckel, Glou Morceau, Forelle, Easter, Kieffer, and others. All these are used commercially.

The grower may have a very wide range of selection or may be very restricted in his choice. For his own use he may prefer varieties that have a wide range of season and a wide variation in the qualities for which the pear is famous. If, however, he wishes to sell to the fresh market from a small acreage of each variety, he may choose from the foregoing list, which experience has shown to be valuable under California conditions. If he expects to grow rather large acreages of any variety for sale as fresh fruit, he would be wise to choose from the six varieties listed as most important in California. Finally, if he desires to market fruit for canning and drying as well as fresh he must choose the Bartlett, which alone has a three-way outlet. Furthermore, he should acquaint himself with the behavior of the varieties of his choice in a given district, since the tree and the fruit are both sensitive to their environment.

There are no young varieties among the standard ones. The Madeleine is now more than three hundred years old. Of the six most important in California, the youngest, the Comice, is now about a hundred years old. Among all those mentioned, the youngest, Clapp, is now about eighty years. Such a situation attests the worth of these varieties. It may also indicate how thoroughly the field has been explored in developing new varieties within the species *Pyrus communis*.

Among commercial growers in California, varieties are usually spoken of as early pears, Bartlett, and fall and winter pears. Early pears are those ripening ahead of Bartlett; fall and winter pears those ripening after it.

DESCRIPTION OF VARIETIES

Anjou (*Beurré D'Anjou*).—In appearance the fruit of Anjou is of a distinct type, medium to large, with a smooth skin, greenish, sprinkled with russet, and sometimes faintly blushed (fig. 3). The flesh is white, melting, juicy and sweet, of finest flavor. The fruit is borne on a short, thick stem. The trees attain large size. In California the normal shipping date is about August 10. The origin of Anjou is unknown, although it is supposed to have originated in the vicinity of Angers, France, some time about 1800. It was introduced into the United States about 1842.

[10] California Coöperative Crop Reporting Service. Acreage estimates of the California fruit and nut crops as of 1939.

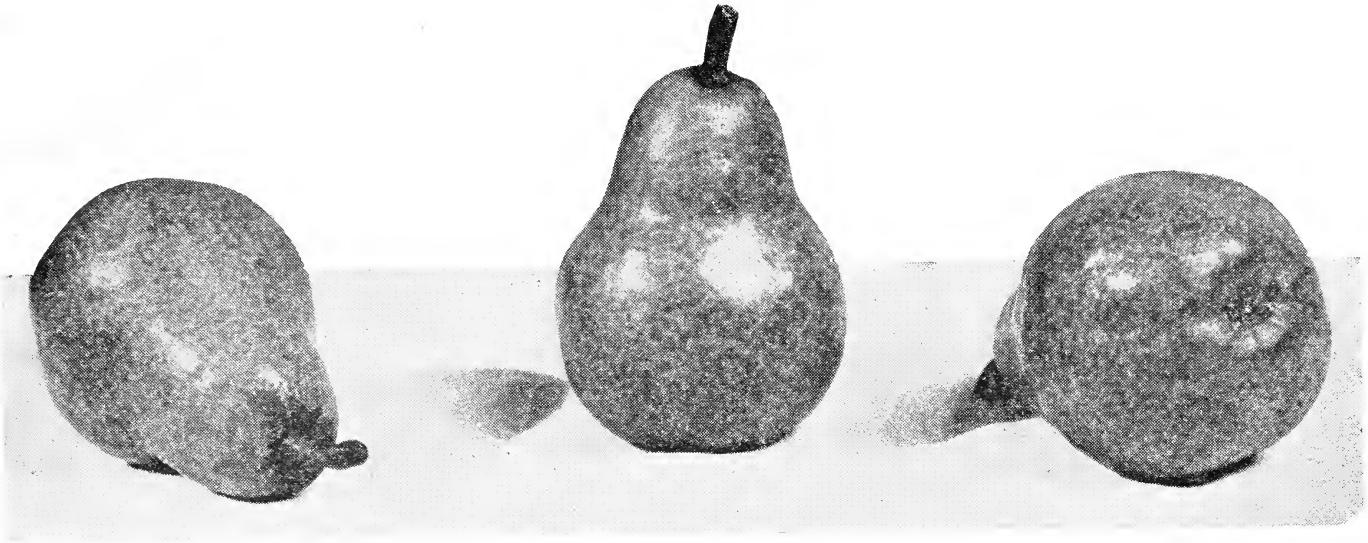

Fig. 4.—Bartlett. When fully ripe, fruits of this variety are large, smooth, clear yellow, with white flesh, fine-grained, juicy, and delicious. This variety is popular all over the world. Normally sizes run heavy, 120's to 180's in the standard box. (Courtesy, California Fruit Exchange.)

Bartlett (*Williams, Williams' Bon Chretien*).—This pear, as has been indicated previously, is by far the most popular in California. It vies with Kieffer in having the greatest number of trees of any variety in the United States. The fruits of the Bartlett (fig. 4) are more common and popular in American markets than any other variety. This popularity is justified from the standpoint of the grower and seller if not always from that of the consumer. The Bartlett is remarkably adaptable to different soils, climates, and situations. It bears early, heavily, and regularly. The pears are large and attractive. Though not of the highest quality, they are well above the average, and they keep and ship well. The fruit also makes an excellent canned and dried product. The trees have an upright habit of growth and, in the early years, need spreading by pruning. As they become older, they are spread by the crop. Under good growing conditions, they reach medium to large size, but never so large as some other varieties. They are very subject to fire blight. In California the season varies from the last of June until the middle of September, according to the district.

The Bartlett was found as a seedling growing wild near Aldermaston, Berkshire, England, by a Mr. Stair. Mr. Williams, a nurseryman at Turnham Green, Middlesex, then acquired, propagated, and distributed it. It became known as the Williams or as Williams' Bon Chretien, although at Aldermaston it is still known as Stair's pear. Brought to the United States in 1798 or 1799, it was planted on the grounds of Thomas Brewer at Roxbury, Massachusetts, under the name of Williams' Bon Chretien. In 1817 a Mr. Enoch Bartlett acquired the Brewer estate and, not knowing the true name of the pear, allowed it to go out under his name. Only in America is it called Bartlett; elsewhere it is still Williams or Williams' Bon Chretien.

Bosc (*Beurré Bosc*).—The fruits of this variety (fig. 5) when well grown deserve unqualified praise. The long tapering neck and beautiful golden russet color cause them to stand out. The tender, melting, juicy flesh, of rich aroma and flavor, rates among the best in dessert qualities. Although not extensively planted in California, it seems to thrive in Santa Clara and El Dorado counties, where the largest plantings are located. The trees are somewhat hard to propagate and train. The normal shipping date is about August 15.

This variety originated in Belgium from a seed planted by Dr. van Mons. It was introduced into the United States about 1832.

Clairgeau (*Beurré Clairgeau*).—The fruit of Clairgeau, which is large and attractive, has only medium or below-medium quality. The flesh is rather coarse and granular; the pear sells on its appearance. The trees reach good size and are highly vigorous. Although there are commercial

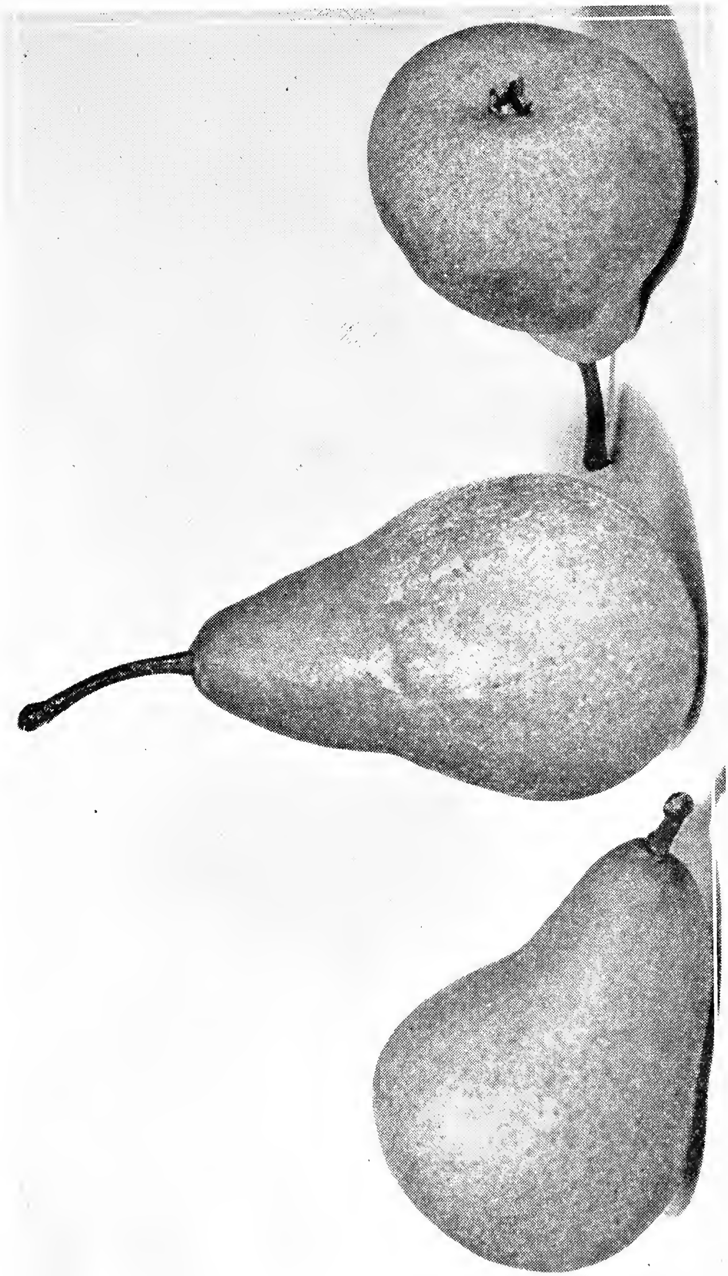

Fig. 5.—Bosc. Fruits of this variety are large and have long necks. The color is a beautiful golden russet. They have rich flavor, and are especially favored for baking purposes. These pears are usually packed in standard boxes, running heavy: 100's to 180's. The fruit carries well to distant markets. (Courtesy, California Fruit Exchange.)

plantings, this variety cannot be recommended unless part of its value will come from its use as an ornamental. It is easy to grow and might well be compared with the Ben Davis among apple varieties. In California the normal shipping date is about September 5.

The Clairgeau seems to have originated as a chance seedling in France about 1830. It was introduced into America about 1854.

Clapp (*Clapp Favorite*).—The Clapp Favorite ripens a week to ten days before the Bartlett, which it resembles in size, shape, color, and flavor. In pear-growing sections of eastern United States and Canada it is first to be put on the market. As the fruit softens at the center soon after being picked, it is suited only for local trade. The tree is highly resistant to low temperatures and bears as heavily as any pear except the Kieffer. Among the standard varieties, it is one of the most susceptible to fire blight, a weakness that bars it from most pear-growing sections.

The variety was raised by Thaddeus Clapp in Massachusetts, but the date of its origin is not known. It was mentioned as a promising variety in 1860.

Comet (*Lawson*).—This is the earliest of the pears grown commercially in California. The fruit is medium to large, yellow with a crimson blush. Its earliness seems to be the chief recommendation, for the quality is only medium. The normal shipping date is about June 5.

The variety originated in New York about 1800 on the farm of a Mr. Lawson. Near the end of the nineteenth century it was introduced as Comet because of its color. It is known as Lawson, Comet, or Lawson Comet.

Comice (*Doyenné du Comice*).—The fruit of this variety (fig. 6) is called by many the best of all pears. The fruits are large, roundish, greenish yellow with thick stems. When ripe they are a clear handsome yellow, sometimes with a delicate blush, marked with russet spots. Because, however, certain weaknesses of the tree have offset this superb quality, the variety has never been widely planted. The tree is rather exacting as to soil and climate; even if hardy and vigorous, it does not always bear regularly and well; it is subject to fire blight. In certain sections of the Pacific Coast where it does well it is an excellent pear; because of its excellent quality, it is specially packed and advertised for the holiday trade. In California the normal shipping date is about August 10.

The Comice originated as a seedling in France some time before 1849, in which year it produced its first fruit. It was immediately placed on the market and reached America the following year.

Dana Hovey (*Winter Seckel*).—The quality of this small dessert pear is of the best. It is pale yellow with considerable russet. The flesh is juicy, sweet, melting, aromatic. It keeps well in storage, the season being from

Fig. 6.—Comice. The fruits are large, roundish with uneven sides and thick stems. They are greenish yellow, but when ripe the color becomes a clear yellow, shaded crimson, and marked with russet spots. The flesh is fine and aromatic. Sizes run heavy: 100's to 180's in standard boxes and 35's to 60's in half boxes. This variety is very popular for export. (Courtesy, California Fruit Exchange.)

October to January. Although its small size seems to be against its commercial use on a large scale, it is excellent for home planting.

The variety originated in Massachusetts before 1854, the year when it was introduced to the public.

Dearborn (*Dearborn Seedling*).—This variety has almost disappeared from California. Although the fruit is melting, juicy, and of good quality, its small size has limited its commercial use. The tree, however, is excellent, being vigorous, productive, and hardy. It would seem to deserve a definite place in the home garden, especially where only a minimum amount of care can be given it. It ripens a little ahead of the Bartlett.

Early Bartlett.—The identity of the variety grown under this name in California is uncertain. It seems that instead of a new variety it may be the Dr. Jules Guyot, a pear closely similar to the Early Bartlett. The fruit is large and yellow, with a coarser and thicker neck than that of the Bartlett, and ripens about a week earlier.

Easter (*Easter Beurré*).—This variety is harvested as late as any pear commonly grown in California and probably keeps longer. The normal shipping date is around October 1, and the season extends until March. The fruit is large, roundish, and yellowish green, with russet dots and patches. The eating quality is good.

This variety was growing in the monastery gardens at Louvain, Belgium, as early as 1823, when it was already an old tree. Propagated and distributed by van Mons as Pastorale de Louvain, it has been widely disseminated under a variety of names; but by authorities in England and America it is called Easter Beurré.

Forelle.—This variety is especially pleasing to the eye. It is highly colored, with troutlike specklings; Forelle is German for trout. The flesh is highly flavored and buttery. This variety is not extensively grown in California. It is one of the most susceptible to fire blight. The normal picking date is about September 20.

The Forelle apparently originated in Germany at the beginning of the eighteenth century, traveled to Flanders and England, and was sent thence to the United States in 1823. In the East it has been replaced by the Vermont Beauty, a pear closely similar or perhaps identical.

Glou Morceau.—This variety is not extensively planted in California. The fruit, rather large, is a greenish yellow, with russet markings. The quality is good. It matures among the last of the winter pears, being normally shipped about September 5.

The variety was originated by the Abbé of Mons, M. Hardenpont, about 1750. It was known in France under various names until about 1820, when it was sent to England as Glou Morceau ("delicious morsel"

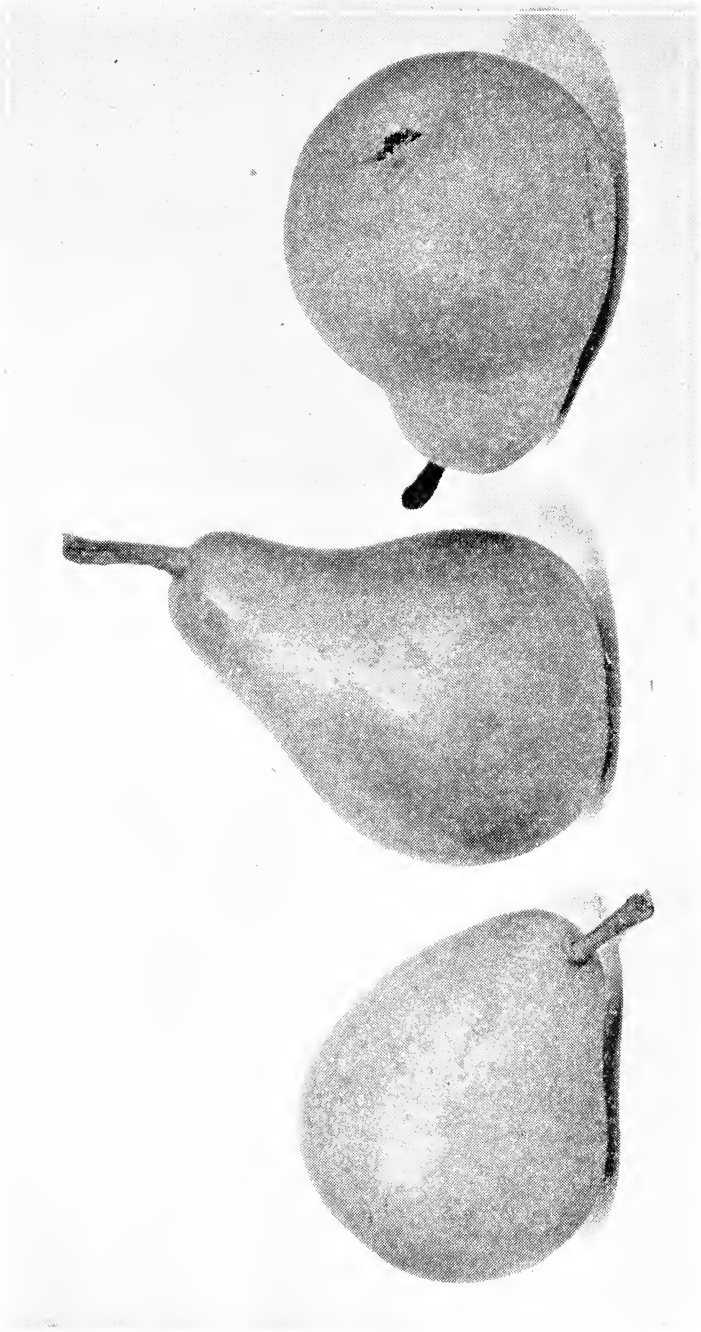

Fig. 7.—Hardy. The fruits are large, oblong, and have the stem on one side. The skin is green with brown russet. The flesh is white, with a rich, slightly acid flavor. The variety is a good keeper, highly recommended, and extensively exported. Sizes run heavy; from 135's to 180's in standard boxes. (Courtesy, California Fruit Exchange.)

or "dainty bit"). It was introduced to the United States soon after this date.

Hardy (Beurré Hardy).—This large, handsome fruit (fig. 7) is the most extensively planted in California of any variety other than Bartlett. The skin is tender and slightly russeted; the flesh sweet, juicy, aromatic, and of the best quality. It ripens a little after the Bartlett and in some sections is harvested between the first and second Bartlett pickings. Almost the entire crop is exported. The trees, sturdy and vigorous, bear heavily.

The variety originated in France about 1820 and was introduced into the United States within a few years thereafter.

Howell.—The fruit of the Howell is attractive because of its smooth, glossy skin, its symmetrical shape, and its clear color. The flesh, though fine-grained and juicy, is only medium in quality. Although the tree bears early and regularly it blights so badly that it probably deserves little place even in the home orchard. It ripens at about the same season as Bartlett. The variety originated in Connecticut about 1830.

Kieffer.—Kieffer, though low in quality, is very widely planted in the United States. It probably exceeded the Bartlett in the number of trees prior to the heavy plantings of the latter variety on the Pacific Coast. There are several reasons for its wide popularity: the fruit is pleasing to the eye; the tree, vigorous and fruitful, will withstand many unfavorable climatic conditions and is least susceptible to fire blight; and the variety has, in years past, been highly advertised. The quality, however, is so low that the Kieffer cannot be recommended for California.

This pear originated from a seed of the Sand pear of China in the garden of Peter Kieffer near Philadelphia. It first bore fruit in 1863.

Madeleine.—The Madeleine is considered by some to be the best very early pear. The fruit is small, pale yellowish green; the flesh, juicy, melting, and delicate; the quality, good. The trees produce prolifically. Although grown because of its earliness, this variety is too small to have much commercial importance. It does deserve a place in the home orchard. It ripens 3 to 4 weeks ahead of Bartlett. It is susceptible to fire blight.

The Madeleine is among the oldest pear varieties; it was being cultivated in France in 1628. Although the date of its introduction into the United States is not known, it was a standard variety in 1831 when it was first described.

P. Barry.—This variety, which originated in California and first fruited in 1873, is not extensively grown. The fruit is distinctly long and is green, with large brown dots. The quality is medium. It is among the latest of the pear varieties and is in season in November and December.

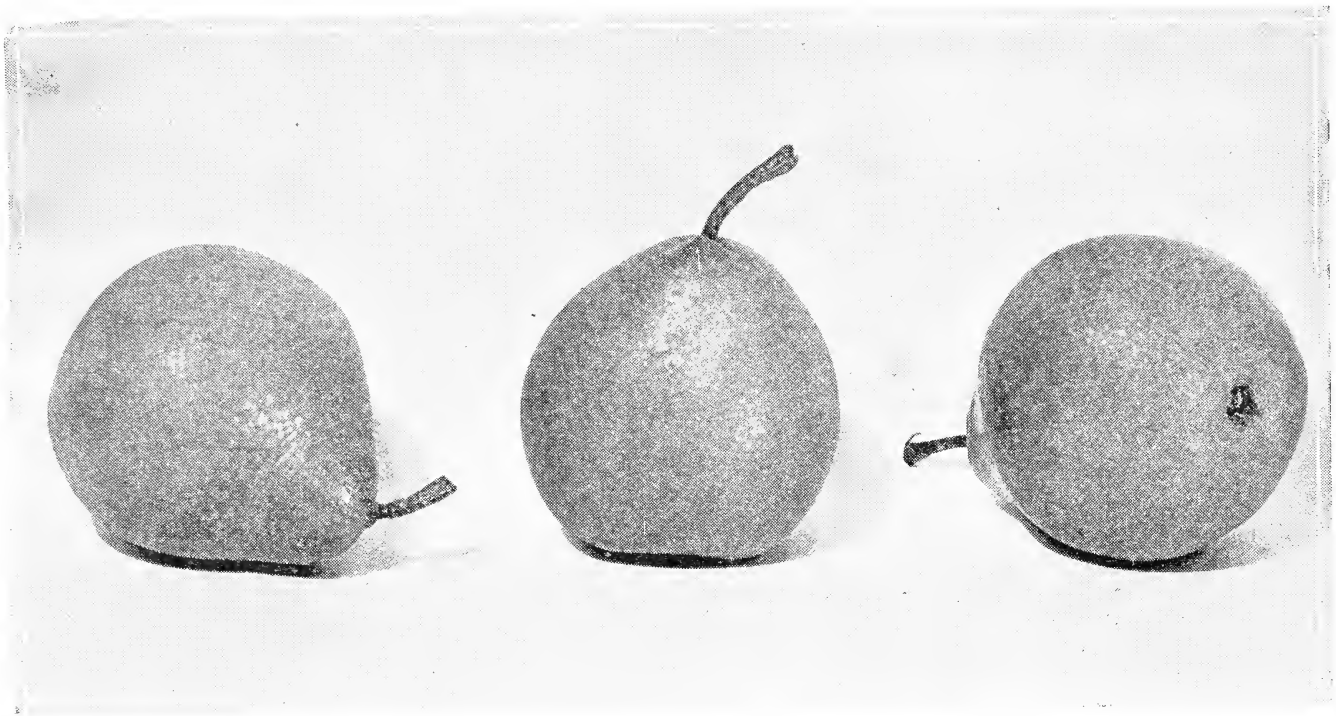

Fig. 8.—Winter Nelis. These pears are of medium size, roundish, with green surface mostly covered with russet when ripening. The flesh is yellowish white, fine-grained. Sizes run heavy: 120's to 195's in standard boxes and 35's to 60's in half-boxes. It is one of the best known and most popular varieties of pears for export because of its long-keeping qualities. (Courtesy, California Fruit Exchange.)

Seckel.—Seckel is an American pear distinct in type from any European variety. Among the several hundred pears that are grown on this side of the Atlantic, Seckel stands almost alone in vigor of tree, productiveness, and immunity to fire blight, and is equalled by no other variety in high quality of fruit. If the fruits were larger the Seckel would challenge the world as a pear for the markets as it now does as a pear for the home orchard. The fruits are small and not especially attractive in appearance. The flesh, however, is excellent for cooking. The variety is recommended especially for the home orchard. It matures about a month after Bartlett.

The Seckel originated as a seedling growing wild near Philadelphia some time before the close of the eighteenth century.

Wilder (Wilder Early).—Next to Comet this pear is the earliest variety grown in California, where limited amounts are produced for the early trade. The quality is good. The normal shipping date is about June 10.

The Wilder originated in New York some time prior to 1884. It was bearing when discovered at this date.

Winter Nelis.—Winter Nelis is the most extensively planted of all the strictly winter pears in California. In acreage it ranks third among the pears of the state, being surpassed only by the Bartlett and the Hardy. The fruits are roundish (fig. 8). In some districts, they are heavily russeted, though elsewhere the russeting may be rather light. Certain strains are said to develop heavy russet. The chief assets of the variety are the flesh and flavor—sweet, juicy, and pleasing. The trees, though strong growers, are unruly and hard to train, but somewhat resistant to fire blight. The normal shipping date is about September 1.

The Winter Nelis originated in Belgium early in the ninteenth century and was brought to the United States in 1823.

PROPAGATION AND CARE OF NURSERY TREES[11]

The propagation of nursery trees takes both time and skill. Although many commercial orchardists do possess the skill, few have time to grow their own nursery stock. Reliable nursery firms propagate satisfactory trees, available in the winter and early spring for planting directly in the orchard. For those, however, who desire to grow their own trees, the methods of propagation are here briefly discussed.

Seed Handling.—Most pear seedlings now produced on the Pacific Coast come from seeds of the Bartlett variety secured from cannery waste. In Oregon and Washington, more than in California, Bartlett is

[11] For detailed description and illustrated methods of budding, grafting, and handling of tree seeds, see: Hansen, C. J., and E. R. Eggers. Propagation of fruit plants. California Agr. Ext. Cir. 96:1–52. 1936.

interplanted with other varieties in order to secure greater production. Because of the cross-pollination thus secured, Bartletts have a higher seed count in the Northwest, and the Oregon and Washington canneries therefore account for most of the pear seed currently used. As experience has shown, these seedlings of Bartlett are much more uniform and vigorous than those grown from imported French pear seed. Seeds of the Winter Nelis variety have resulted in uniform vigorous seedlings perhaps somewhat superior to those from Bartlett with respect to a branched root system and size; but they are usually difficult to obtain because Winter Nelis is less widely grown and is neither canned nor dried commercially.

After collection, pear seeds are washed, dried, and stored in a cool, dry place. About the first of December they should be mixed and covered with damp sand in wooden boxes, which should then be put in cold storage at about 36° Fahrenheit or, if cold storage is not available, placed out of doors in a cool and shady location. The sand must be kept moist throughout the winter, and the boxes should be thoroughly screened against mice. This whole process, known as stratification, is intended to break the rest period and to soften the hard seed coat that surrounds the embryo. In February the seeds are screened from the sand and planted before they sprout. Planting may be either in rows in the open ground or—if only a few seedlings are being grown—in flats or flower pots. The seeds are covered with ½ inch of sifted soil, and clean straw or peat moss is placed over the top to prevent drying out. During this period of germination the soil must be moist, aerated, and loose on top to insure vigorous growth. If started in seed boxes, the plants should be removed to rows in the open ground as soon as they attain a height of 3 inches.

Budding.—If carefully grown, these seedlings may be ready to bud by August or September, when they should be about $\frac{3}{16}$ to ¼ inch in diameter. As a usual practice pear seeds are planted in a seedbed, and no attempt is made to bud at the end of the first summer. After growing there for one season, the seedlings are lifted, the root cut back to 6 or 8 inches, and lined out in the nursery row or are bench-grafted. Those transplanted to the nursery are cut back to within an inch or two of the ground, and a single shoot is developed that uniformly makes sufficient size for budding by August or September. Budding is the most popular method of changing over to the desired variety, although whole root grafting is occasionally used.

About a week before budding, leaves and twigs should be removed within 4 to 6 inches of the ground. This practice facilitates the insertion of the bud into the stock near the ground. The shield or "T" bud is popularly used. Budwood should be carefully selected from thrifty, large

buds of the current-year growth of bearing trees. Success depends upon getting contact between the growing tissue of bud and stock, and securely tying the bud in place to exclude air until it has united with the stock. Budding rubber is used for tying. Union will take place in about 10 days. The following spring, the stock should be cut back to just above the bud to force all growth into the latter, thus forming the top of the budded variety. The developing tree will need good care. At the end of the growing season the one-year-old nursery trees on three-year-old roots are ready to be dug for orchard planting. In case the pear tree has been propagated by whole-root grafts, the root system will be two years of age.

Grades of Nursery Trees.—The Agricultural Code of the State of California specifies that deciduous fruit trees shall be graded by size and age. They shall be not less than ¼ inch in caliper nor less than 8 inches in height except that June buds may be 3/16 inch in caliper. The size is to be measured at a point 2 inches above the center of the bud union. The grades are divided into ⅛-inch series up to ½ inch and then into 3/16-inch series. If the trees are older than one year the age must be stated on the label. The approximate height may be placed on the label. The following groups illustrate the grades commonly made by nurseries for pear trees:

Diameter in inches	Height in feet
11/16 and up	6–8
½–11/16	4–6
⅜–½	3–4
¼–⅜	2–3

The price naturally varies downward with the grade and size. It is doubtful if the smallest trees should be planted if the size is due to lack of inherent vigor. A medium-sized tree is desirable provided it is reasonably stocky, the top well supplied with good buds to within a foot or less of the ground, and the graft or bud union smooth and well healed over. The roots should be straight and well branched, and the whole tree free of insect and disease pests.

Care of Nursery Trees.—Trees from a nursery should be ordered well in advance so that the desired varieties may be obtained and early delivery assured. Although pear trees can be successfully planted from December to April, the earlier in the winter they are set out, the better the development the following season. If they cannot be planted immediately upon receipt, they should be "heeled in" in well-drained soil. This is done by placing them in a trench side by side at the same depth as they grew in the nursery. Loose, moist soil should be sifted around the roots, the trench filled, and the soil carefully packed about the roots. Dry soil should be wet thoroughly after the trees have been heeled in. Trees may be kept in this manner for several weeks before planting. When trees

ordered from a distance arrive dry, the roots may be soaked in water for several hours before heeling in. If the branches also appear dry, the entire tree may be submerged for several hours.

Top-Working.—If the Old Home variety is planted as suggested (page

Fig. 9.—Old Home framework, top-worked to Bartlett.

37), then top-working becomes a standard operation in starting a pear orchard. The Old Home may well be grown for three or four years or until a good framework has been secured. By this time four to six leaders will have been established, with perhaps an equal number of secondaries; these should all be budded or grafted to the desired commercial variety.

The top-working will be done at about 5 feet from the ground, and all buds or scions of blight-susceptible varieties should be inserted in the resistant stock 10 or 12 inches distant from the nearest branch (fig. 9).

Top-working is also done with much older trees if the variety is to be

Fig. 10.—A Glou Morceau tree, fifty-five years old, severely cut back and top-worked to Comice. The grafts placed are in branches that are too large; it will be practically impossible to prevent wood rot in many of the stubs. Compare with figure 11. (From Ext. Cir. 96.)

changed. In this case the top-working will usually be by grafting, and the scion will be inserted in much larger wood. Usually it is profitable to top-work old trees high in the top, even with more work and expense, rather than to sacrifice framework that takes many years to secure (figs. 10, 11, 12, and 13).

ROOTSTOCKS FOR PEARS

Since pears, like other improved fruits, do not come true from seed, one must plant trees that have been propagated on seedling roots by either budding or grafting. These seedling roots are commonly known as "rootstocks."

Until about 1915, France was almost exclusively the source of seed for these pear stocks. The seeds were easily secured from the cider mills of continental Europe, where many pears are consumed as a drink known

Fig. 11.—A somewhat smaller tree than in figure 10 but of the same age and variety in the same orchard. This placing of grafts shows a more desirable practice than that shown in figure 10; the grafts are higher in the tree and in smaller branches. (From Ext. Cir. 96.)

as "perry." From these seedlings came the designation "French pear stock." Botanically, these seedlings are *Pyrus communis,* as are standard varieties like Bartlett, Hardy, Bosc, and Winter Nelis.

The bacterial disease known as fire blight (page 59) is by all odds the

most serious single menace to pear culture, taking as its toll thousands of trees every year in many parts of the world. The Bartlett and other com-

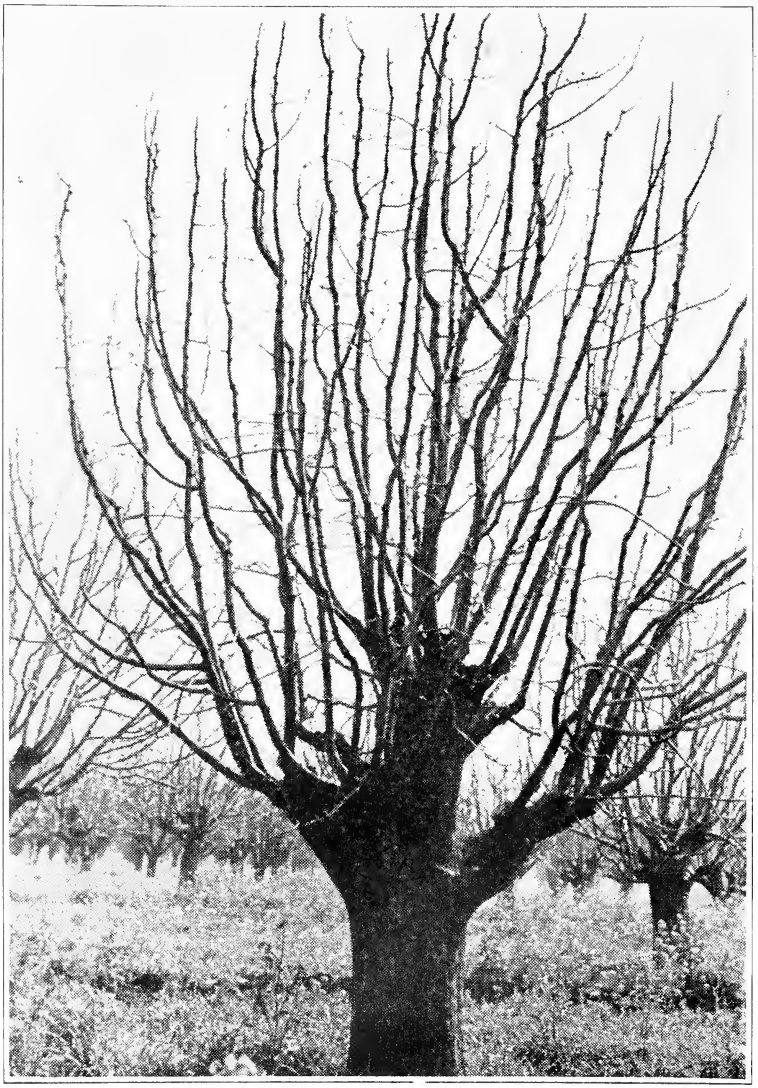

Fig. 12.—The same tree as in figure 10, six years later.

monly grown varieties, as well as the French pear root, are susceptible to this disease.

Most French pear stocks throw up many suckers from below-ground parts; and through these succulent shoots as well as through the susceptible top varieties, the blight organism gains ready entrance to the roots.

In a few of the earlier pear orchards quince (*Cydonia oblonga*) roots were used as a stock, but these also sucker badly and are susceptible.

During and immediately after the World War, the stage was set for

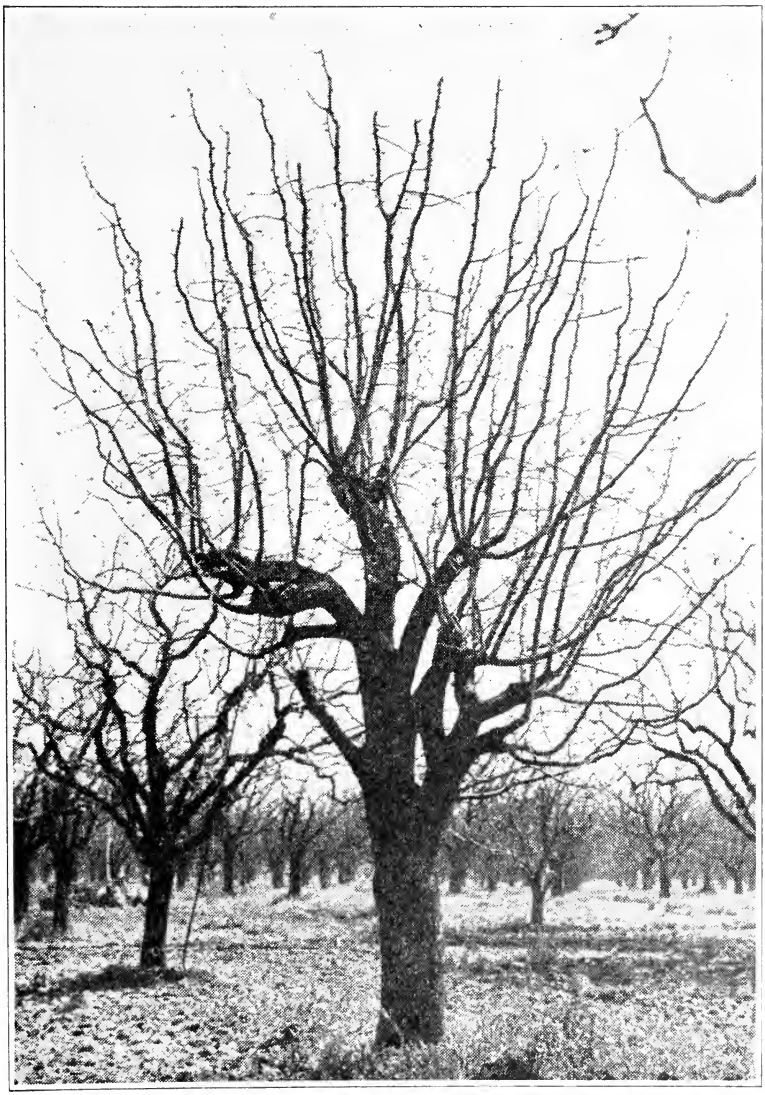

Fig. 13.—The same tree as in figure 11, six years later.

the almost exclusive use of a new rootstock in the rapid expansion of pear acreage at that time. When the old and tried (fig. 14) French stock, *Pyrus communis,* could not be readily secured, a new root, the Japanese stock *Pyrus serotina,* was put forward as equally satisfactory and in addi-

tion, as at least 50 per cent more resistant to fire blight. These claims, as experience has shown, were not altogether true; but since this stock does not sucker readily, there have undoubtedly been fewer root infections than with the old French stock. Because of the greatly increased rate of

Fig. 14.—A large churn-bottom Bartlett pear tree, perhaps sixty years old. Note the bridge at the right used to help heal the wound made in blight-control work. Experience has shown that trees on such roots are consistent and heavy producers.

planting, some ten years after the general introduction of the Japanese root about 30 per cent of all the pear orchards in California were on this stock.

After 25 years' experience with the Japanese root as a stock for pears, California orchardists have concluded—as did South African growers thirty or more years ago—that this stock is unsatisfactory, although it

is entirely desirable from the standpoint of the nurseryman, being easy to propagate and making a thrifty growth in the nursery row. When planted in the orchard, trees on this root generally start well, especially under ideal soil and moisture conditions. In many instances, however, growth slows up after ten or twelve years, and many trees become dwarfed and unprofitable. Although more resistant to pear-root aphids, the stock is more susceptible to oak-root fungus and is also more sensitive to excess soil moisture, to drought, or to a calcareous subsoil (page 32) than is the French rootstock upon which the older trees are growing.

Since the introduction of this root, a disease not caused by either fungi or bacteria has appeared in many orchards. Among thousands of trees producing these affected fruits, only a few have been found to be on French roots, and none whatever on quince roots. This disease, known as "hard-end" or "black-end" because of the characteristic hardening or blackening of the calyx or blossom end of the fruit, was generally recognized by about 1920. In 1927 and 1928, only about 10 per cent of the new trees were still planted on the Japanese root; and now in 1940 it is difficult to find nursery trees thus propagated. In the past ten years many hundreds of acres of pear trees upon this root have been removed because of black-end (page 67).

Besides the Japanese root, *Pyrus serotina,* three other Oriental roots have been used to a limited extent in California pear orchards of recent years. As yet these have not been sufficiently tested to determine their possible value. When, however, the Bartlett variety is worked on *Pyrus ussuriensis,* a blight-resistant root, black-end often develops—a fact that should eliminate this stock from any further consideration. The same statement holds true for the alkali-resistant stock *Pyrus betulaefolia.* Thus far the blight-resistant Oriental pear root, *Pyrus Calleryana* has produced so little black-end that it seems to have definite possibilities. It is too soon, however, to give the final word as to this root.

For centuries the quince root has been used as a dwarfing stock for pears. Unfortunately the Bartlett as well as certain other desirable pear varieties does not make a satisfactory union directly with the quince root. To circumvent the difficulty, double-working has been commonly employed using Hardy to make a satisfactory union with the quince as the intermediate stock. In this "sandwich" tree only an inch or two of the Hardy is necessary between the quince root and the desired top. The double-working usually adds a year's time to the production of a pear tree on quince roots. Under the favorable soil and climatic conditions of California, the quince root gives only a semidwarf tree. Care must be taken not to plant the bud union below the surface of the ground, or in years to come the tree may strike root from the pear top and soon become

a standard rather than a dwarf. The advantages claimed for the quince root are briefly: (1) economy in orchard management due to lower trees; (2) precocious and regular fruiting; (3) larger and better-shaped fruit; (4) earlier maturity in the season; and (5) excellent quality of fruit. The chief disadvantages are: (1) tendency to sucker badly; (2) susceptibility to fire blight; (3) greater cost of propagating double-worked trees; and (4) the necessity of planting more trees per acre.

Apparently, therefore, the safest investments in California pear orchards today are in those on either quince or French roots. Although the French root is highly susceptible to fire blight and to pear-root aphids, it is highly resistant to oak-root fungus and partially resistant to crown gall and root-knot nematode.

With pears, seemingly, the best rootstock practice is to plant on French roots some blight-resistant variety such as Old Home and then, when these trees are three or four years of age, to top-work them to the Bartlett or some other commercial pear variety. The result is a resistant framework, but with blight-susceptible roots. Orchards which have reached ten years of age indicate that this practice is satisfactory.

Surprise, Farmingdale, Lemon, and Variolosa as well as Old Home have been tried experimentally as the intermediate framework. At present (1940) Old Home appears most promising because it is (1) highly resistant to fire blight; (2) vigorous, spreading, and upright in growth; (3) readily budded or grafted to standard varieties; and (4) satisfactory on either French or quince roots. The single weakness which the Old Home has exhibited after a trial of twenty years is its occasional susceptibility to a canker trouble (page 63). The Lemon variety, in limited trials, has shown considerable promise, especially because of vigor, form of tree, and ease of top-working.

An attempt has been made to produce Old Home trees on their own roots so that below-ground parts will also be blight resistant. This variety does not grow by cuttings and grows only poorly by layering. A few trees of Bartlett budded to Old Home on its own roots produced by layering have done as satisfactorily as those on French seedling roots. In limited experimental plantings, Old Home trees on both quince and French roots, when placed with the graft union well below the surface of the ground (1 to 2 feet), apparently form roots rather readily above the union.

Conceivably, before many years have elapsed, there will be available rootstocks resistant to fire blight and also not a cause of black-end. This aim may perhaps be accomplished by vegetative propagation of blight-resistant varieties now grown for trunk and framework branches, or by securing blight-resistant French seedlings.

ESTABLISHING THE ORCHARD

The successive steps in establishing the commercial pear orchard include grading the land, installing the irrigation system, laying out or locating the tree positions, planting, and caring for the young trees.

Grading the Land.—The proper preparation of land is highly important. Sites fairly uniform as to slope require very little grading. Usually, however, the land must be graded to conform to the irrigation system and to facilitate the distribution of water. It should not be scraped so deep as to result in infertile spots, which prevent the normal growth of the trees.

Installing the Irrigation System.—In practically all areas in California, irrigation is required for successful pear culture. The irrigation system, therefore, should be installed before planting. It is possible to "tank" the trees the first year in the orchard and postpone the pump installation.

Laying Out the Orchard.—Most California orchards are planted by the square system, in which the trees and rows are the same distance apart and at right angles to each other. Pear trees are planted 16 to 24 feet apart. In determining the most desirable distance, one must consider many factors. If trees planted too close together make a vigorous growth, undue crowding will occur. If, on the other hand, the trees are too far apart, maximum crops per acre cannot be secured. Where growth is very good, furthermore, the trees become too tall for economical handling, a condition that cuts down the net returns. Many California orchards planted 20 to 22 feet apart produce 12 to 20 tons an acre. For usual conditions and for "standard" trees, this planting distance appears to be the most economical, although the orchard shown in figure 15 planted 18 feet apart by the triangle method has yielded as high as 45 tons of marketable fruit per acre. A smaller number of trees per acre might have yielded just as satisfactorily. Dwarf trees on quince roots may be planted as close as 12 feet, though in fertile soils this may prove to be too close.

There are numerous ways of laying out the orchard (locating the tree positions).[12]

Planting.—The earlier in the winter the trees can be planted, the better. It is impossible, however, to get trees from the nursery much before January. Although planting may be done as late as March, an earlier date is to be preferred unless soil or weather is unfavorable.

For planting, if the ground has been properly prepared, the holes need be only large enough to accommodate the roots in their natural

[12] Wickson, E. J. The California fruits and how to grow them. 10th ed. p. 85–92. Pacific Rural Press, San Francisco. 1926. (Out of print.)

position. Unduly long roots may be shortened, and damaged roots removed. The soil should be well firmed around the roots by tamping it down or by running water around the trees immediately after planting. The trees should be placed at the same depth they grew in the nursery. They must not be diseased or infested with root insects.

After planting, many protect the trees from sunburn by means of tree protectors or whitewashing, particularly if the orchard is planted under unfavorable conditions. If, however, the trees are planted early, under good growing conditions, sunburn is seldom a problem with pears.

Fig. 15.—An orchard of Hardy, planted 18 feet apart on the triangle.

A good whitewash may be made as follows: quicklime 5 pounds, salt ½ pound, sulfur ¼ pound. Add the salt and sulfur while the lime is slaking. Allow the whitewash to age several days. Then dilute it to buttermilk consistency so that it is easily applied with a brush. Another good formula consists of whiting 6 pounds, casein spreader 1 pound, raw linseed oil ⅓ pint. This sticks better than the lime whitewash but is more expensive.

If the grower wishes to use tree protectors he should be sure that they are properly put on and not removed or broken off during the summer. They should be forced down into the soil so that during subsequent working around the trees they will not slip lower, exposing the trunk bark which, having become tender because of the protector, will sunburn more

readily if exposed. Another objection to tree protectors is that most persons use those that come up almost to the top of the tree, forcing all lateral growth from around the top of the trunk and making it impossible to select framework branches well distributed up and down the trunk.

Care of the Young Trees.—After the orchard is set out, the trees should be kept growing vigorously. Normally, clean culture should be practiced; and irrigations should be frequent enough to protect the trees from lack of moisture.

Sometimes the orchardist wishes to grow intercrops in the young, developing pear orchard. Given good soil and plenty of water, there is no objection, provided the intercrops are not promoted at the expense of the trees.

The growers should control all insects and diseases that interfere with normal growth. The pests likely to require treatment will be discussed elsewhere in this circular.

A young pear orchard seldom needs artificial fertilizers, provided that a good orchard soil has been selected.

TRAINING AND PRUNING PEAR TREES[13]

At the time of planting, young trees should be cut back to 24–30 inches from the ground in order to balance the loss of roots removed in digging from the nursery and in order to form a low head for future profitable orchard management. At the first pruning, three branches are selected to give proper spacing up and down the trunk; all others are removed. If the tree makes a good start, one may select these main scaffolds during the first summer in the orchard by pinching back the undesired shoots and forcing all the growth into those left untouched. This vertical spacing is more important than balancing the growth around the stem, since the next season's shoots take care of the latter problem. The distance between the origin of the branches on the trunk never changes during the life of the tree. If possible, these scaffolds should be 6 to 8 inches apart.

Pinching back the surplus shoots the first and second summer is beneficial: it strengthens the shoots left untouched and reduces the pruning necessary the following winter. As a rule, summer pruning is weakening, although it may be desirable if there is a tendency to shade out growth in the interior of the tree or if there is danger of breakage.

First Dormant Pruning.—If summer pinching has been practiced, there is little to do the first winter. The framework branches are headed back moderately (15 to 30 inches) to a point where secondary branches are desired. In heading the three laterals for the framework, the top one

[13] For a general discussion of pruning see: Tufts, Warren P. Pruning deciduous fruit trees. California Agr. Ext. Cir. 112:1–68. 1939.

should be left a little longer than the other two so that it will not be choked out by the more vigorous growth of the lower branches (fig. 16). This arrangement gives rise to the modified-leader type of tree. If sufficient spacing has not been secured during the first season, the grower

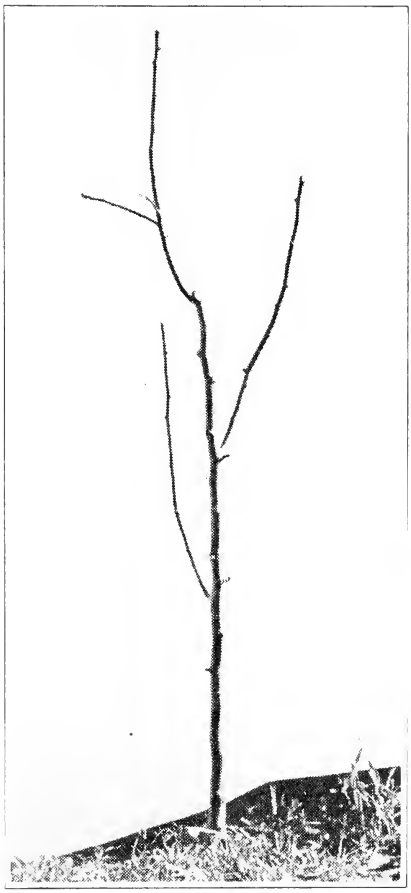

Fig. 16.—A young Bartlett pear tree after the first dormant pruning.

should save only two shoots at the first pruning, cutting one relatively short, the other long.

Second Dormant Pruning.—At the second dormant pruning the secondary framework branches should be selected. Generally each of the three branches forming the original framework will give rise to two or more shoots, from which three to five secondary scaffolds are selected; all other vigorous growth is removed (fig. 17). Each of these scaffold branches will be headed at the point where the tertiary branching is de-

sired. Where only two scaffolds have been left at the first pruning, two shoots are saved from the longer branch, and only one from the shorter. Such treatment almost uniformly gives an excellent framework; and

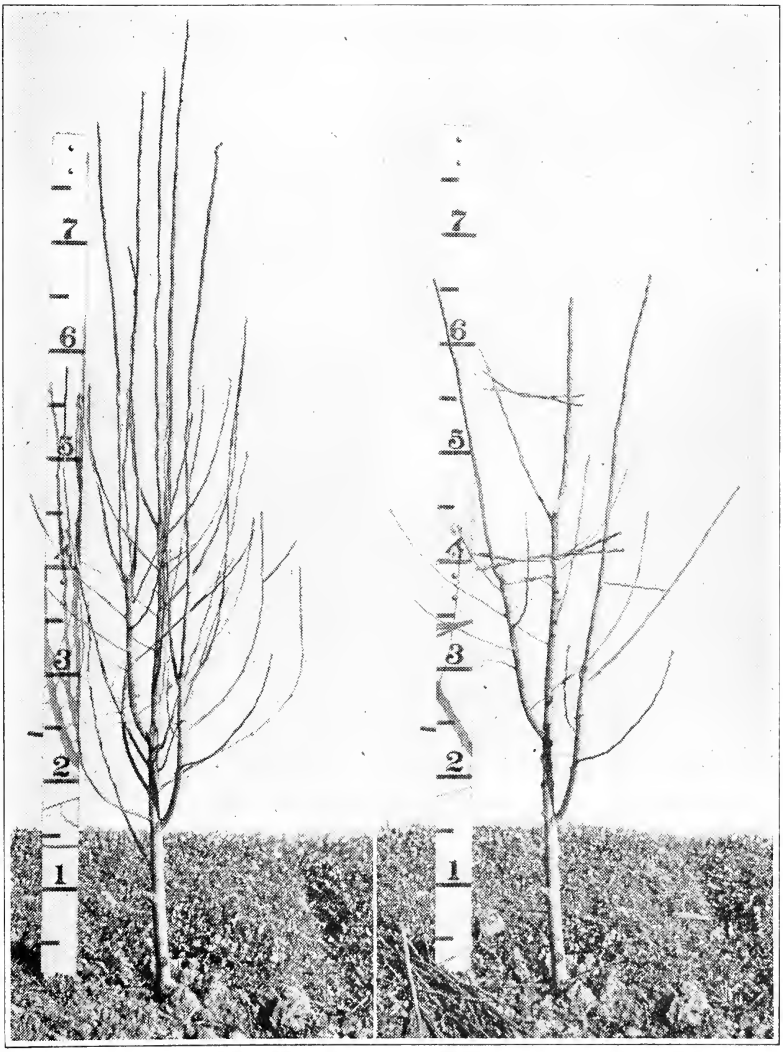

Fig. 17.—A young Bartlett pear tree before and after the second dormant pruning.

although this takes longer to secure, fruiting is not necessarily delayed for a corresponding period.

Third and Subsequent Prunings of Young Trees.—Beginning with the third dormant pruning and continuing until the framework is complete, each of the three to five scaffold branches selected at the second pruning

are headed at the point where the next whorl of branches is desired. The other shoots are thinned out and left unheaded—unless a minor scaffold

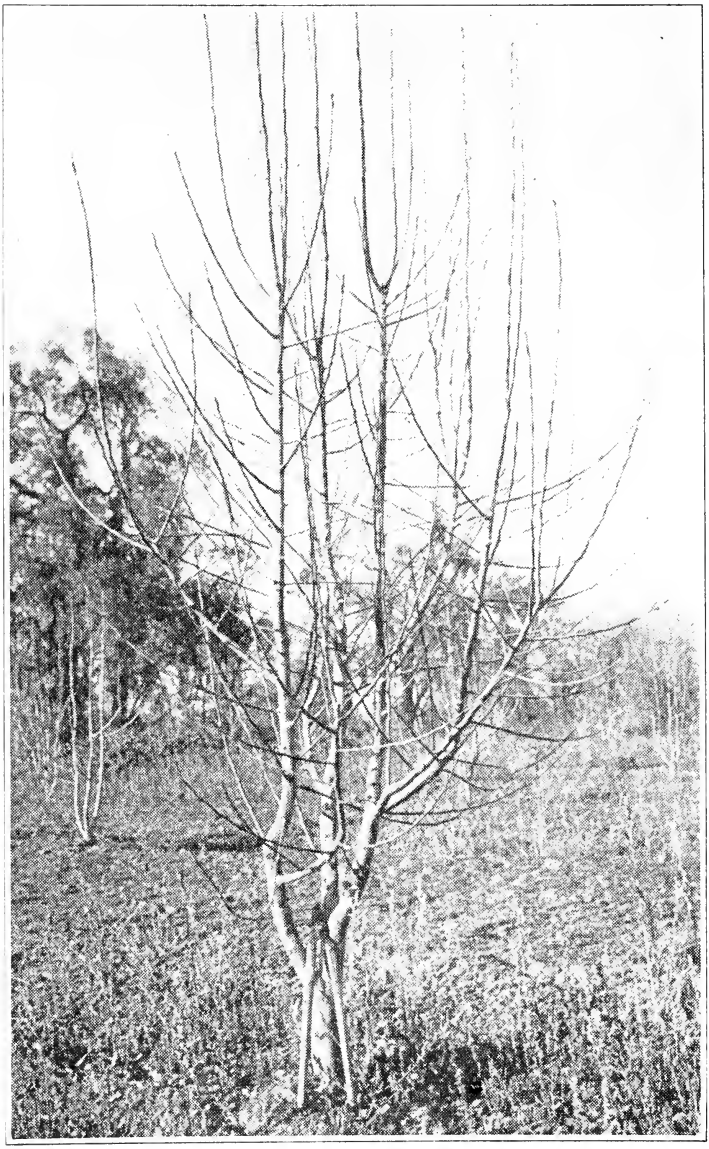

Fig. 18.—A young Bartlett pear tree before the third dormant pruning.

is desired, in which case this shoot is headed more severely than the main scaffold to avoid weak crotches and secure strength (figs. 18 and 19).

After securing the desired number of main branches with proper

spread and height one gains nothing by a further heading back. Lightly pruned nonbearing trees have stockier and stronger trunks and branches. The lighter the pruning, the greater the development. To check any

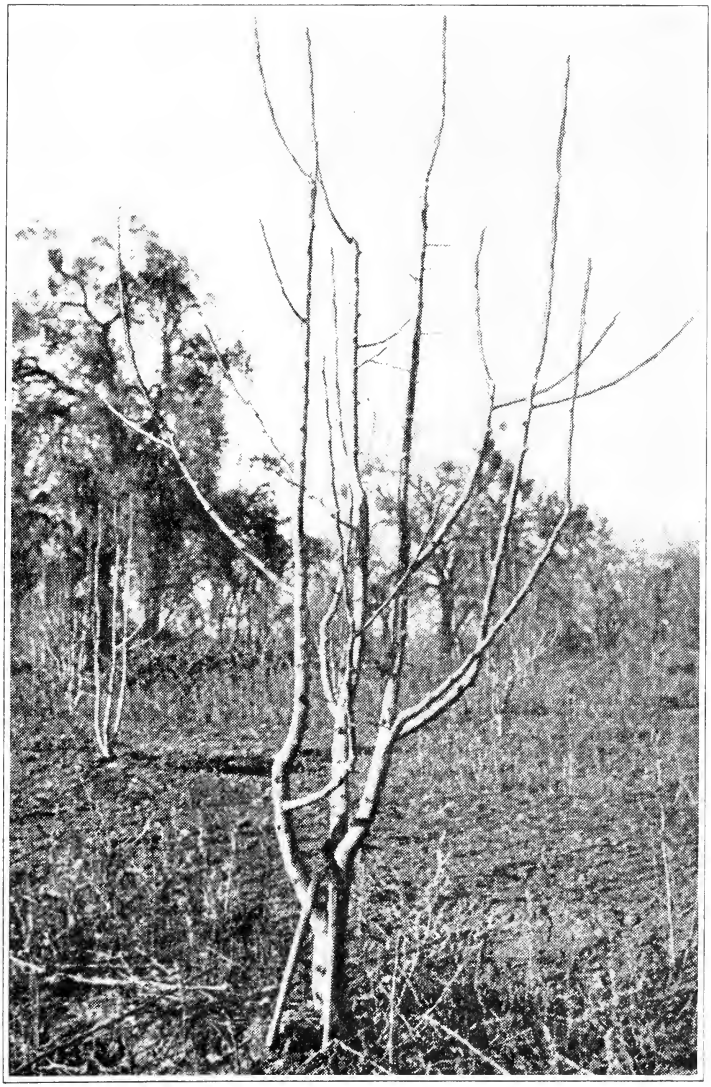

Fig. 19.—The same tree as in figure 18 after the third dormant pruning.

branch or part, cut it heavily. To encourage any part, prune it lightly or not at all. Lightly pruned trees bear sooner than trees similarly located, but heavily pruned. Early bearing in itself is not antagonistic to future productivity.

Caldwell System.—Among the most interesting departures from standard pear pruning practice is the "Caldwell system" (fig. 20), which briefly stated, consists in tying down the upright one-year-old shoots at an angle somewhat below the horizontal. The resultant new growth arises just below and behind the highest point of the bend. Practically all growth beyond this point is reproductive in character and rapidly develops a good fruit-spur system. In principle the Caldwell plan resem-

Fig. 20.—Caldwell system of pruning. (From Bul. 386.)

bles the espalier method of training used in Europe; in both cases the bending of the branches seems to induce fruitfulness. At each dormant season all the new shoots are so tied down that the lower branches are shaded as little as possible. The later tying is done to any convenient point on either trunk or branch.

Briefly, the advantages claimed for the method are as follows: large trees of good mechanical strength, combined with a large fruiting area close to the ground, are secured in a comparatively few years; they come into bearing two to four years earlier than trees severely cut back; they can be trained to a more shapely form in a windy section or where prevailing winds hinder symmetrical development; and finally, they produce larger crops of equal quality.

The chief disadvantage is that this system must be part of a compre-

hensive and intensive orcharding program. Since all wood is conserved, adequate moisture and fertility must be maintained in order to secure an abundance of new wood while carrying large crops through to maturity and supplying an enormous leaf area that is being increased from year to year. In most soils, as soon as the trees begin bearing heavily, some renewal pruning is needed to replace the fruiting wood that has

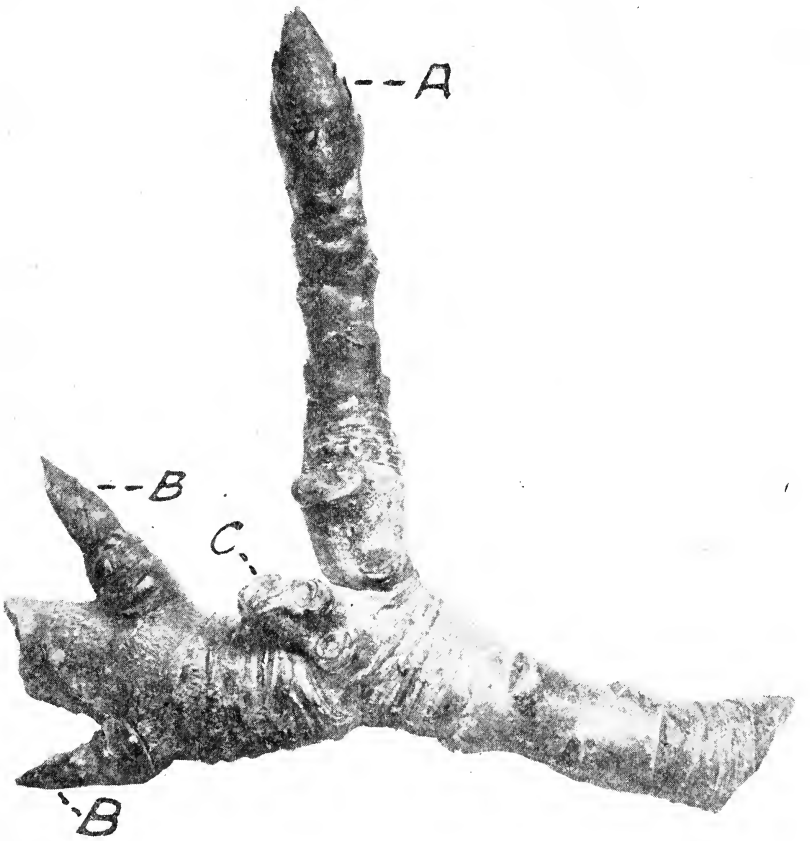

Fig. 21.—Fruiting habit of the pear. Note the terminal fruit bud at *A*, and two lateral leaf buds at *B*. Fruit was produced at *C* during seasons preceding that in which buds *A* and *B* were formed. Growth of "*B*" buds will give rise to characteristic branching of older pear spurs. (From Bul. 386.)

outlived its usefulness and to maintain proper vegetative vigor. Success largely depends upon skill and judgment. The method is probably applicable only to pears during the years of training and should not be adopted without a full understanding of its requirements and limitations.

Fruiting Habit of the Pear.—Pears are borne upon long-lived spurs, whose economic life is seven or eight years. The fruit is produced from a terminal bud one season; the next season, the spur elongates a little and sets another terminal fruit bud; and the following season, fruit is again produced (fig. 21). Under special conditions certain varieties, such as

Fig. 22.—A Bartlett pear tree growing in the Sacramento Valley. Compare it with the tree shown in figure 23.

the Bartlett, bear lateral or even terminal buds, upon one-year shoots. These buds generally blossom a week or 10 days later than the spur buds and in frosty locations may often produce a major portion of the crop. Since these fruit buds on one-year shoots are generally produced on the terminal one third of the shoots, any such growth being left for fruit production should not be headed.

Pruning Bearing Trees.—If properly pruned when young, a bearing tree will be well formed and mechanically strong. After a tree begins to bear fruit, pruning is intended chiefly to maintain a balance between fruit production and vegetative growth. Excessive shoot growth is made at the expense of the fruit crop, and excessive fruiting in any one year

Fig. 23.—Bartlett pear tree growing in the Santa Clara Valley. Compare it with the tree shown in figure 22.

prevents the production of a satisfactory crop the following year. The ideal situation is to have the trees making only a fair amount of growth each year and at the same time bearing an average crop. Many growers consider the conformation of the tree important, with a considerable portion of the fruiting wood maintained relatively low on the tree.

A judicious thinning out of new shoots and of an occasional older branch is more desirable than a heavy heading-back that results in considerable succulent growth susceptible to blight. Thinning rather than heading stimulates spur formation. If trees are headed or cut back se-

Fig. 24.—A mature Bartlett pear tree after pruning; age about twenty-five years. (Lake County.)

verely, too much energy may be devoted to renewing vegetative growth rather than producing fruit. Heavy heading may also cause a dense top growth that shades the interior of the tree, preventing the development of fruit buds. Vigorous vegetative growth, whether in young trees or

induced in older ones, often results in rough pears which are undesirable both for cannery and for shipment as fresh fruit. In a fully matured pear tree, a new growth of 6 to 10 inches each year is all that is needed.

The Bartlett as grown in various districts in California may respond to the same pruning treatment in radically different ways. In the Santa Clara Valley it is a precocious bearer; and early fruiting must be prevented, at least in part, until sufficient size and framework are secured. After bearing size is attained, the pruning should be more severe than in the Sacramento Valley in order to maintain sufficient renewal wood and to prevent the production of excessive crops of small fruit. In the Sacramento Valley, on the other hand, away from coastal influences, vegetative growth is vigorous; and difficulty is often experienced in bringing trees into bearing. Here pruning should be relatively light, and new growth thinned without the heading back that is usually desirable in the Santa Clara Valley (figs. 22, 23). Not only is there a distinct difference in fruitfulness in the different districts, but the wood produced is distinct. Bartlett pear wood in the Santa Clara Valley is distinctly softer and more brittle than in the Sacramento Valley. The foothill pear sections, Lake and Mendocino counties, Suisun Valley, and the great pear section of the delta of the Sacramento River apparently provide environments somewhat intermediate between those of the upper Sacramento and the Santa Clara valleys.

Fig. 25.—Mature Bartlett pear tree after pruning; age about twenty-five years. (Sacramento County.)

When the Bartlett tree reaches full maturity and completely occupies the space allotted to it, both above and below ground, there is apparently little or no difference in size of crop and time of fruit maturity occasioned by any reasonable system of pruning. This, judging from careful

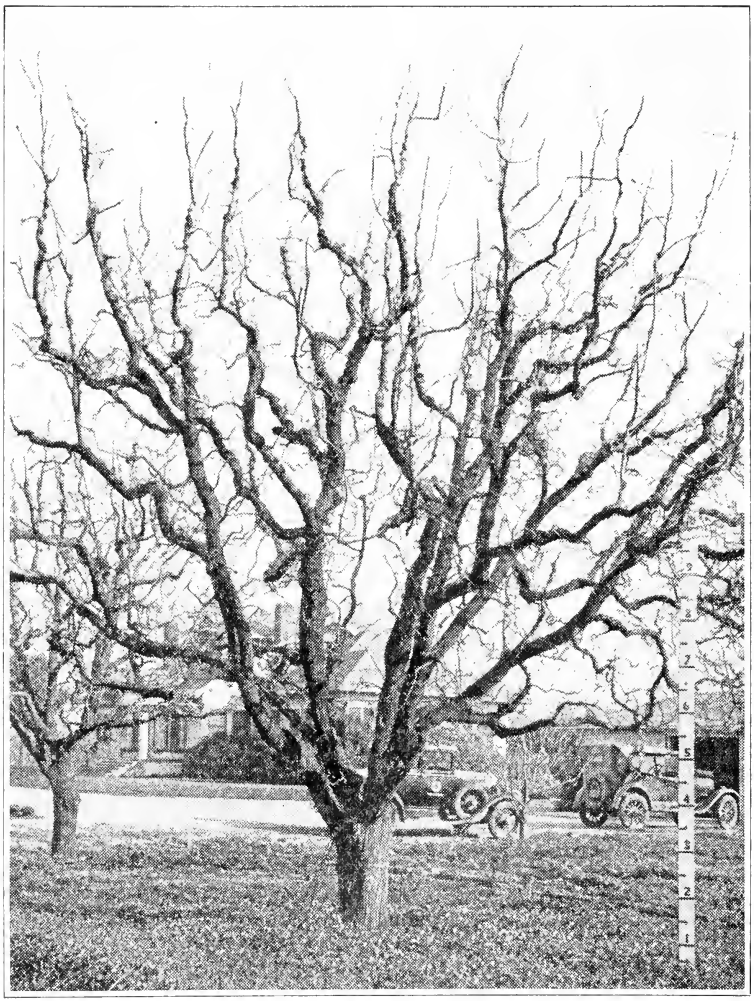

Fig. 26.—An old Winter Nelis pear tree after pruning.
(Santa Clara County.)

observation and some experiment, is true regardless of the district. In other words, if sufficient replacement wood is secured and if trees are not pruned so severely as to limit the crop, it makes no difference whether such results are obtained by thinning, by heading, or by a combination of the two.

Cross branches, and interfering and weak branches should be thinned out. Since fire blight enters the tree largely through blossoms, the grower

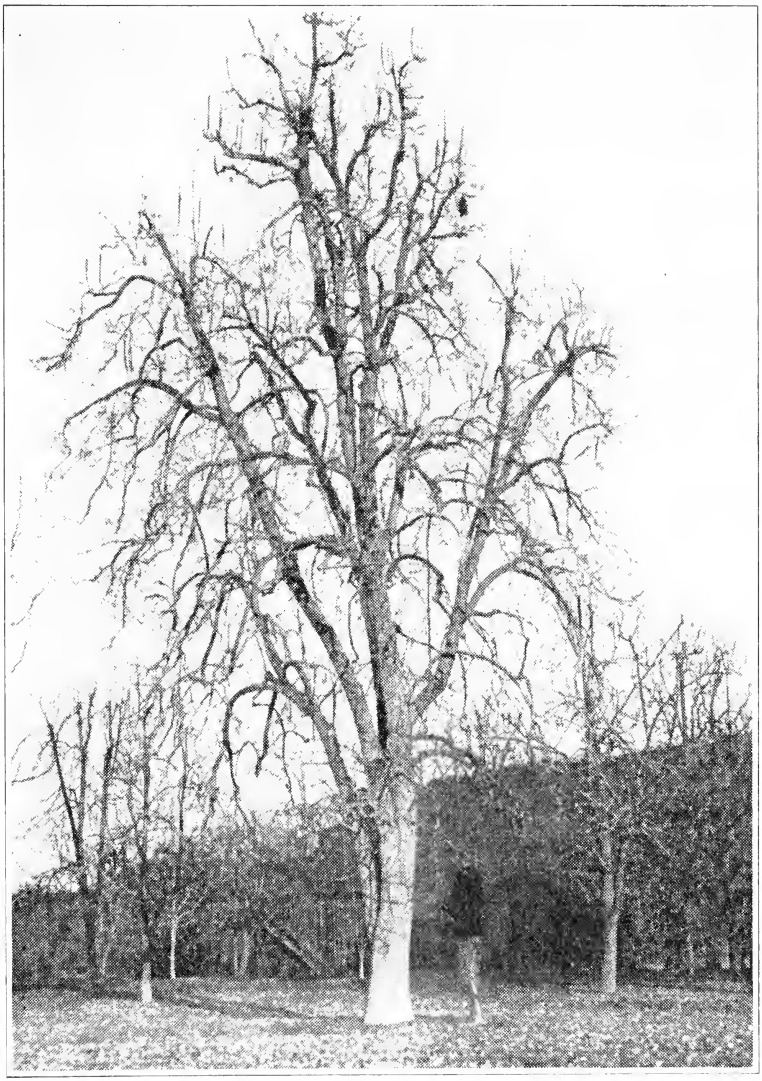

Fig. 27.—A Bartlett pear tree about seventy-five years old, probably neglected during much of its life. Notice the great height, the central leader shape, and the few main scaffold branches. (Lake County.)

should keep the main limbs free from fruit spurs, encouraging instead the spurs on smaller branches remote from the main scaffold limbs.

Figures 24, 25, and 26 show mature pear trees in Lake, Sacramento, and Santa Clara counties after the annual dormant pruning. Figure 27 is of a very old Bartlett tree, probably neglected much of its life. It has

attained a rather desirable shape despite the neglect; but its height, approximately 40 feet, is far beyond any commercial feasibility.

Treatment of Pruning Wounds.—The form of treatment of pruning wounds depends upon local climatic conditions. In foggy climates favorable to the germination and growth of fungi, which cause wood decay, the wounds should be disinfected as soon as the wood has dried a little, but before any cracks have formed. Bordeaux paste is a good disinfectant and wound covering, but must be replaced every year or two until the wound has completely healed.

In localities where the air is fairly dry, disinfection of pruning wounds will ordinarily be unnecessary; but in any case large wounds should be covered with the same protective substance—not to aid the healing, but to keep out rot-causing fungi.

Besides bordeaux paste, other materials, not disinfectants, are often used as wound coverings. For this purpose white-lead paint mixed with raw linseed oil has been widely employed. There are many proprietary materials for covering pruning wounds—mostly asphaltum compounds or emulsions that may be applied cold.

CARE OF THE PEAR ORCHARD

Cultivation.—The usual reasons for cultivation are as follows:[14] to remove noxious weeds and weed competition; to facilitate subsequent orchard operations such as irrigation, harvesting, brush removal, and spraying; to incorporate covercrops and manures; to prepare the soil as a seedbed for covercrops; and to aid in the absorption of water where tillage or other orchard operations have produced an impervious condition of the soil.

The covercrop, either volunteer or planted, which has grown during the winter should be turned under in the spring. If possible the cultivation should not be delayed until the covercrop has become too bulky to be easily turned under or too well matured to decompose readily. It is not desirable, however, to cultivate when the soil is wet; delaying the cultivation until the upper layers of soil have somewhat dried out will minimize the danger of compacting the soil or of causing a plowsole to form. Spring cultivation should be done thoroughly to incorporate the covercrop into the soil. The second cultivation will usually not be necessary until after the first irrigation. If the weeds are numerous or large or if the soil has become too compact for furrows or levees to be constructed, it may be necessary to cultivate before the first irrigation. Where water is plentiful and the soil does not crack so badly as to render

[14] Veihmeyer, F. J., and A. H. Hendrickson. Essentials of irrigation and cultivation of orchards. California Agr. Ext. Cir. 50:1–24. Revised 1932.

the levees useless, many growers use the same levees for more than one irrigation. If the soil cracks on drying, it will be necessary to cultivate the levees before reconstructing them. The frequency of cultivation throughout the summer depends largely upon the available water supply and upon certain orchard operations.

Intercrops.—The growing of an intercrop in a young orchard as a source of income is a frequent practice. The choice of crop used probably makes little difference if the grower remembers that his primary interest is the best development of the young trees. The chief reason for planting an orchard is usually that it will yield greater returns than some other crop. The sooner the trees reach full bearing, the sooner will these returns be achieved. The intercrop, therefore, should hinder as little as possible the most rapid development of the young trees.

Covercrops.—During the fall or winter the growing of some covercrop, to be incorporated in the soil early in the spring, is a common practice. The cover may be a volunteer crop of winter-growing weeds, or one that has been planted. If manure has been applied to the orchard, the volunteer crop will usually be heavy. If planted, the covercrop should be one that will give a desirable amount of green manure to incoporate in the soil in the spring. The growth of the various plants used for the purpose depends upon such environmental factors as soil, water supply, and temperature during the growing season. Thus certain covercrops that need warm weather to make a good start after planting thrive where the temperatures are higher during the fall but would fail in areas where the autumn months are cooler. The grower should plan for an abundant growth during the fall and winter after planting. Among the common leguminous plants used for winter covercrops are annual yellow sweet clover (*Melilotus indica*), common vetch (*Vicia sativa*), and purple vetch (*Vicia atropurpurea*). Among the nonleguminous plants most commonly used are the mustards and the cereals—rye, barley, and oats. These are generally planted from the middle of September to the middle of October in order to be established before cold weather. To induce germination, additional water may be needed. In some sections pear orchards have been successfully handled with permanent covercrops such as in the foothill areas. It is necessary under this type of management to have sufficient water available for both trees and covercrop.

Commercial Fertilizers.—Nitrogen is the only commercial fertilizer to which the pear has responded. It will not, however, always prove effective even when such fruit trees as the peach or apricot would show marked response on the same soil. In one experiment in Lake County,[15] pear trees have been benefited by applications of nitrogen; in a number

[15] Proebsting, E. L. Fertilizing deciduous fruit trees in California. California Agr. Exp. Sta. Bul. 610:1–29. 1937.

of other experiments in the state, no response has been obtained. A grower would be wise to test a fertilizer on a small block before using it on his entire orchard.

Fire blight is an additional consideration: when the trees respond to fertilizer applications by additional growth, the blight hazard will usually be increased. The grower may well prefer a smaller growth to the difficulties associated with increased susceptibility to blight.

Fruit Thinning.—Fruit thinning is not commonly practiced on pears in California. By making a number of pickings, one can usually allow the smaller fruits to size and relieve the trees sufficiently to prevent serious breakage. Where crops are extra heavy, thinning is occasionally practiced. Under these conditions the work is not done until a few weeks before picking; and the crop is lightened chiefly by removal of the very small and blemished fruit.

Bracing.—At maturity the pear tree, if well trained, is strong enough to carry a considerable burden. With a very heavy crop, however, especially where the pruning has left an abundance of fruiting wood, the tree may be braced to prevent serious damage to large branches. Under these conditions growers have used wooden props or have tied the tree with rope. More expensive braces are rarely justified for pear trees.

Irrigation.—Pear trees should have readily available water throughout the growing season. Otherwise they will quickly show an adverse response in decreased tree and fruit growth. Fruit that has fallen behind in its size because of insufficient moisture during the growing season will never regain the size obtained on other trees that were not allowed to suffer for lack of available moisture.

The trees should be irrigated before the soil becomes dry—that is, before the permanent wilting percentage has been reached. At each irrigation sufficient water should be applied to restore the soil in the root zone to its field capacity. The amount of water needed may vary considerably—not only with the type of soil but also with the depth in which the roots are growing. Thus in the foothills, where the depth of rooting is limited by solid rock, or in areas where the water table is high each winter, the root zone may be only 2 or 3 feet deep. Under these conditions much less water will be needed at any one time than if the roots were growing as deep as they choose, but it will have to be applied more often. The trees should always have available water, although an excess should be avoided.

PEAR POLLINATION

Pollination Status of Pear Varieties.—The pear falls in that group of fruits whose pollination requirements are not constant. Some varieties are always self-unfruitful and therefore always need cross-pollination.

Others are just the reverse. In the third group are a number, including the Bartlett, that will set part of a crop with their own pollen but will usually have the crop increased by cross-pollination. The Bartlett is typical of a peculiarity within this group, that of apparently having different pollination requirements under different conditions. Thus many years ago, in one of the large pear orchards in the East, the Bartlett was observed never to set without cross-pollination. In the foothill section of California, a somewhat similar situation exists; yet in the Sacramento River section the Bartlett sets satisfactory crops most years in the absence of other varieties.

The Division of Pomology of the University of California has investigated the pollination requirements of a number of pear varieties under California conditions. The available data are presented in the following discussion.

In the Sierra Nevada foothills the Bartlett was found experimentally to be almost completely self-sterile. This finding agrees with the general opinion of growers that this variety must be cross-pollinated to produce satisfactory crops.

Under interior-valley and coastal conditions the Bartlett is self-sterile to a limited extent. In the opinion of a good many pear growers, the crop could be appreciably increased by cross-pollination, especially in certain years when conditions are unfavorable. In these sections, however, many orchards planted solidly with Bartlett have been producing satisfactory crops. Conceivably, though the crop might be increased by cross-pollination, the increase would not be profitable: the problems associated with heavy bearing such as the failure to size so well, the delay in picking, and the possibility of accentuating the tendency to bear alternately might offset the returns from the increased tonnage. The grower should weigh such considerations as these. He can usually be guided, also, by the experience of other growers working under similar conditions, by the farm advisor, or by the agricultural commissioner.

The pollination status of pears other than Bartlett, as shown by experimental crosses at the University Farm at Davis, is shown in the following tabulation:

Self-sterile varieties	Years tested
Alencon	2
Bloodgood	2
B. S. Fox	1
Comet	1
Forelle	2
Le Conte	3
Madeleine	1
Winter Nelis	3

Self-fertile varieties	Years tested
Comice	4
Flemish Beauty	1
Hardy	3
Howell	3

Doubtful varieties	Years self-fertile	Years self-sterile
Angouleme	1	1
Anjou	2	1
Bosc	1	1
Clapp	1	1
Clairgeau	2	2
Colonel Wilder	2	2
Dana Hovey	1	2
Easter	1	2
Gifford	1	1
Glou Morceau	1	1
Kieffer	1	4
P. Barry	3	2
Seckel	1	1

Those listed as self-sterile are varieties that failed to produce fruit when pollinated with their own pollen. Those listed as self-fertile set a crop with their own pollen, but they also always set a heavier crop on the open-pollinated or normal-set blossoms. Thus, although these varieties may be expected to produce good crops without pollinizers, the advantage of cross-pollination is evident because those trees were located in a variety orchard, where abundant opportunity for cross-pollination was afforded. The doubtful varieties are those that have not behaved consistently from year to year. In addition to those varieties listed, the Bartlett may be successfully fertilized with Old Home pollen.

In the Santa Clara Valley and in Sonoma County, Clairgeau, Comice, Howell, Hardy, and Winter Nelis are self-sterile or practically so, whereas Bosc, Easter, and Glou Morceau are self-fertile.

Under Sierra Nevada foothill conditions Anjou, Comice, Dana Hovey, and P. Barry are self-sterile or nearly so; Bosc is doubtful.

Choice of Pollinizing Variety.—Once the grower has determined that he needs cross-pollination, he encounters certain other problems connected with his choice of a variety for crossing—namely, (1) the commercial value of the pollinizer, (2) the date of bloom of the pollinizer and of the main variety, (3) the amount of pollen produced, (4) the viability of the pollen, and (5) the compatibility of the two varieties. The last three points are of no concern in pear growing. All varieties examined produce abundant viable pollen, and no cases of intersterility have been found.

The ideal pollinizer would be one equal in commercial value to the

main variety and maturing at a time that would fit into the other operations. Since unfortunately, such a perfect condition rarely occurs, the grower often must decide how few trees of the pollinizer he can get along with. If the pollinizing variety is relatively undesirable as compared with the main one, every third tree in every third row or one tree in nine is regarded as the minimum number that can be used for successful crossing. In this arrangement each tree of the main variety is adjacent to a pollinizer. If more trees of the pollinizer are desired, they should be planted

TABLE 3

AVERAGE BLOSSOMING DATES OF CERTAIN PEAR VARIETIES
UNIVERSITY FARM, DAVIS; 1914 TO 1923 INCLUSIVE

Variety	Years averaged	Blossoming dates	Beginning of full bloom
Kieffer	9	March 17 to March 30	March 24
Howell	9	March 20 to April 2	March 24
Forelle	9	March 19 to April 2	March 25
Clairgeau	9	March 21 to March 31	March 25
Easter	9	March 20 to April 2	March 26
P. Barry	8	March 20 to April 7	March 27
Glou Morceau	9	March 24 to April 7	March 28
Winter Nelis	10	March 23 to April 4	March 28
Bartlett	10	March 23 to April 8	March 29
Comice	8	March 25 to April 4	March 30
Anjou	6	March 24 to April 7	March 30
Gifford	6	March 23 to April 8	March 31
Comet	7	March 24 to April 8	March 31
Seckel	8	March 25 to April 7	March 31
Hardy	7	March 25 to April 8	April 2
Clapp	6	March 26 to April 11	April 2
Colonel Wilder	6	March 26 to April 10	April 2
Bosc	4	March 29 to April 10	April 3

in solid rows—for example, two rows of pollinizer, then three or four of the favored variety.

The pollinizer and the main variety must bloom concurrently, or their blossoming must overlap. Fortunately most pears except such early blooming ones as the Le Conte, Forelle, and Kieffer, overlap reasonably well. Only when the rest period has not been properly broken will certain varieties such as Bartlett be delayed and fail to overlap sufficiently. Table 3 shows the average blossoming dates of a number of varieties at Davis.

Pollinating Agencies.—Bees are the best carriers of pollen. If none are present, it will pay to rent a few stands. One stand per acre is generally recommended. The work of the bee depends, however, upon climatic conditions. Cold weather, besides killing the blossoms and lowering the vitality of the pollen, prevents the bees from flying. Wet, windy, or cloudy weather is likewise not conducive to the best work of the bee.

PARASITIC DISEASES AND THEIR CONTROL[16]

Fire Blight.—Fire blight,[17] caused by a bacterial organism (*Bacillus amylovorus*), is the principal disease of pears in nearly all districts of the United States. Often it is the chief limiting factor in production. It affects many other plants such as apple, cotoneaster, hawthorn, pyracantha, quince, and toyon.

All the commonly planted varieties of pears in California are distinctly susceptible, although some such as Anjou, Comice, and Winter Nelis are less so than others such as Bartlett, Hardy, and Bosc.

Any part of a susceptible tree may be blighted, including the roots. Infected shoots and blossoms become watery, darken rapidly, wilt, and die. Usually small milky to brownish beads of gum appear on blighted parts. Infections on trunks and branches (cankers) commonly appear around the bases of blighted shoots and blossom spurs or at points where the bark has been cut or broken. The interior of diseased bark is at first watery, then reddish mottled, and later brown to black. The disease may advance for some distance in the outer bark before the inner bark is killed.

Although the blight organism may overwinter on any of the plants mentioned above, by far the most common spring source in pear orchards is the pear tree itself. The germ is carried from cankers to blossoms either by splashing rain or by such insects as flies and ants, and it may spread among the young shoots by such sucking insects as aphids and tarnished plant bugs. The principal spread, however, is from blossom to blossom by insects. Even when only a few blossoms are killed in the main blossom period, infections may build up to considerable numbers in the scattered late blossoms of early summer or even in those which appear in some orchards at the end of summer.

Control of established blight is tedious and difficult, best attempted only by an operator who is experienced and painstaking. It is essential that all possible overwintering infections be removed from the orchard and its vicinity before the blossoms open. After new infections appear, the trees should be examined at least once a week as long as blight is found. Infected blossom spurs, shoots, and small branches are best cut off. As the organism in tender tissue is often several inches in advance of any visible symptom, cutting through the blighted part rather than below it is probably the most common cause of failure. On vigorous trees,

[16] This section was contributed by H. Earl Thomas, Plant Pathologist in the Experiment Station.

[17] For a more detailed treatment of fire blight see: Thomas, H. Earl, and P. A. Ark. Fire blight of pears and related plants. California Agr. Exp. Sta. Bul. 586:1–42. 1934.

therefore, the cuts can seldom be safely made short of 12 inches below the nearest discolored bark. The shears and wounds should be treated with a good disinfectant.[18] The common practice of suspending blight control work for several weeks before and during harvest and sometimes until the end of summer is a dangerous one at best and may result in the loss of considerable numbers of entire trees since many infections do not remain inactive as they may appear to be during the dry season. However thorough the work may be, it is still important that a careful examination of the orchard be made in autumn for at this time any remaining cankers are likely to be spreading rapidly downward toward or into the roots.

Cankers may be treated in any one of the following three ways. In all cases the treatment should extend several inches beyond the visible margins of the cankers.

1. A zinc chloride solution[19] is brushed or poured on the surface of the bark, which should be made thoroughly wet with the solution; with rough bark it is desirable to remove the outer scales before making the

[18] Directions for making mercuric-chloride and mercuric-cyanide disinfectant: These two poisons are sold at most drug stores as tablets or powder. Although either form may be used, the tablets are more convenient for small quantities and dissolve more easily. The tablets of mercuric chloride referred to below are of the size containing 7.3 grains. A solution containing glycerin, about 10 per cent by volume, wets the tools better and evaporates more slowly than a water solution. A solvent containing three parts glycerin to one part of water has been used extensively and is satisfactory except for the additional cost. The proportion of glycerin to water can be varied considerably, but the proportion of the mercury compounds to the solvent should not be changed without good reason. The disinfectants described below are based on a strength of 1 part of each ingredient to 500 parts of solvent.

A solvent containing approximately 10 per cent glycerin can be made as follows: For 1 pint use 14 ounces of water and 2 ounces glycerin; for 1 gallon use 7 pints water and 1 pint glycerin.

To make 1 pint of disinfectant add 2 tablets mercuric chloride and 2 tablets mercuric cyanide to 1 pint of solvent.

To make 1 gallon of disinfectant add 16 tablets of ¼-ounce powdered mercuric chloride and an equal quantity of mercuric cyanide (also either tablets or powder) to 1 gallon of solvent.

This disinfectant should be kept only in glass or earthenware containers. *It is deadly poison.* (Antidote: Give the patient olive oil, or a large amount of water or milk, or white of egg beaten up in water; induce vomiting; and send for a doctor.)

[19] Zinc chloride solutions are prepared by dissolving zinc chloride powder in a solvent consisting of 7 pints of denatured alcohol, 2 pints of water, and 3 ounces of hydrochloric acid, making approximately 9 pints of solvent. It must be prepared in glass or enamelware and stored in tightly corked bottles.

9 pounds of zinc chloride in 9 pints solvent makes a 53 per cent solution.

6 pounds of zinc chloride in 9 pints solvent makes a 43 per cent solution.

4 pounds of zinc chloride in 9 pints solvent makes a 33 per cent solution.

The solutions are more easily prepared by first dissolving the zinc chloride in the 2 pints of water by boiling, then adding the acid, and lastly pouring this mixture into the denatured alcohol. *Zinc chloride solutions are dangerous poisons.* (Antidote: Give the patient olive oil, or a large amount of water or milk, or white of egg beaten up in water; induce vomiting; and send for a doctor.)

application. The most satisfactory strength of solution should be determined by trial in the individual orchard. The prospective user should consult Extension Circular 20[20] or 45[21] if a copy is available. By this method an experienced operator may treat rapidly and effectively the numerous small cankers that develop on trunks and branches in a severe outbreak of blight; but the following methods are more effective in treating the larger cankers, especially in fall and winter.

2. Scarification consists in shaving off the affected outer bark and then treating the exposed inner bark and wood with the mercury disinfectant. This method is particularly applicable in spring and early summer to cankers that are small to large in area but not yet deep-seated.

3. Scraping is similar to scarification except that the affected bark is removed entirely down to the wood. This method is best for dealing with large cankers in fall and winter. The wounds made in this operation should also be treated with the mercury disinfectant, and large wounds should be protected afterward with a dressing.

Attempts to prevent blight infection by spraying at blossoming time with bordeaux mixture and other materials have proved beneficial in a few cases. The results, however, are still highly unpredictable; and considering the cost and the possibility of spray injury, spraying as a general practice for blight control is still of doubtful value. Where both blight and scab are serious problems, there is more reason for spraying during the blossoming period, since applications at this time should be of about equal effectiveness for scab control to those made a little earlier or later. To growers who are committed to spraying for blight control it may be suggested that a weak bordeaux mixture be used (1–1–50, or weaker) beginning when about 20 per cent of the blossoms are open. A second application at about full bloom would increase the chance of success.

Light pruning, growing a covercrop, or any other procedure that reduces the vigor of tree growth will diminish the severity of the disease; but such practices are usually valuable only as supplements to more direct methods of control.

Several oriental and other species of pears have been tested as possible rootstocks and some of them are highly resistant to blight. But none of them has thus far proved equal in all respects to the ordinary French (*Pyrus communis*) roots. The most promising stock at present, there-

[20] Day, Leonard H. Pear blight control in California. California Agr. Ext. Cir. 20:1–50. 1928. (Out of print. Usually available at the office of the farm advisor or at city libraries.)

[21] Day, Leonard H. Zinc chloride treatment for fire blight cankers. California Agr. Ext. Cir. 45:1–13. 1930. (Out of print. Usually available at the office of the farm advisor or at city libraries.)

fore, seems to be French root with the highly resistant Old Home variety grafted on it to provide the trunk and main branches on which the desired fruiting variety is later budded.

Blast.—The blast disease of pear is caused by a bacterial organism (*Bacterium syringae*) closely resembling (if not identical with) those that cause gummosis in many stone fruits, blast and black pit of citrus, and diseases of many other plants. Blast in pears sometimes appears very similar to fire blight and may be confused with it. An attempt, however, should be made to distinguish blast from fire blight, for if the drastic

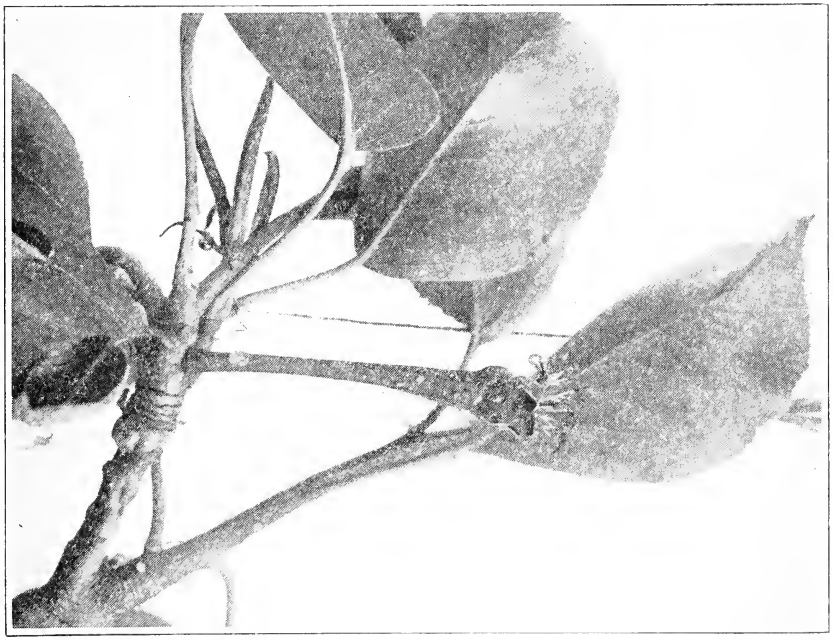

Fig. 28.—A blighting blossom cluster, showing drops of bacterial exudate on a young fruit and at the base of a shoot. (From Bul. 586.)

control measures necessary for blight control are applied to blast, the result will be an unwarranted expense and a loss of fruiting wood. Blast may usually be differentiated by the absence of gummy exudate, the failure to penetrate the spurs for more than an inch or so, the light color of bark on new cankers, and the shredding of outer bark on old cankers (figs. 28 and 29).

Blast is more active in winter and early spring than during the summer, sometimes causing considerable loss of dormant buds. Blossoms may be severely blighted, particularly in Winter Nelis. The organism may enter through buds, blossoms, cluster bases, lenticels, or pruning wounds, sometimes producing numerous separate cankers on a single tree. The

affected bark at first is tan or brown. Later the outer layer is loosened and sloughed off in papery shreds, usually leaving the inner bark alive. The canker phase may be found on Anjou, Bartlett, Bosc, Wilder, Easter, Old Home, Surprise, and Winter Nelis. Severe infection of Bartlett has not been seen except on trees weakened by other causes.

Fortunately—since no satisfactory control is known—blast is not a major problem in the average year. The removal of severely affected stone-fruit trees from the vicinity of pear orchards and of as many cankers as possible from the pear trees will doubtless be of some value.

Fig. 29.—The blast disease of pear, showing localized type of injury in the blossom cluster and the cluster base. (From Bul. 586.)

Fruit Pitting.—There are several types of fruit pitting besides those explainable on the basis of hail, insect punctures, and mechanical injuries. One affecting the Anjou particularly is believed to be related to the use of Japanese rootstock. (See discussion of black-end.) Others found on Bosc and Hardy are perpetuated by buds and scions from affected trees. This fact suggests the desirability of examining the fruit of trees from which buds are to be taken for propagating nursery stock.

Root Rots.—The pear on French root is highly resistant to the root rot caused by the oak-root fungus *Armillaria mellea;* only a few such trees have been lost by this disease. Roots of the Japanese pear, *Pyrus serotina,* and of *P. ussuriensis* are definitely more susceptible than French roots.

the tree. Excess lime in the soil quickly renders any iron added to the soil insoluble and unavailable. Experiment has shown, however, that iron may be added directly to the trees and the chlorotic condition thus cured.

A satisfactory method of preparing the tree for the introduction of iron is to bore ¼- to 7/16-inch holes in the roots, in the trunk either above or below ground, or in the branches. The holes should be bored at intervals of 3 to 4 inches apart around the root, trunk, or branch, and 1 to 3

TABLE 4

DOSAGES AND HOLES FOR TREATING NONBEARING* CHLOROTIC TREES BY THE DRY-SALT METHOD†

Tree diameter, inches	Holes			Amount of iron salt	
	Number	Diameter, inches	Depth, inches	Per hole, ounces	Per tree, ounces
1	1	¼	⅝	0.01	0.01
1½	1	¼	1	0.02	0.02
2	1	7/16	1¼	0.05	0.05
3	3	7/16	1¼	0.03±	0.1
4	4	7/16	1½	0.05	0.2
5	5	7/16	1¾	0.06	0.3
6	6	7/16	2	0.08±	0.5
7	7	7/16	2	0.08±	0.6
8	8	7/16	2½	0.09	0.7
9	9	7/16	2½	0.09	0.8
10	10	7/16	2½	0.1	1.0
15	15	7/16	3	0.1	1.5
20	20	7/16	3	0.1	2.0

* For bearing trees the dosage should be reduced to about one half or two thirds of that indicated in the table unless experience has shown that there is no danger of injuring the blossoms.

† Table reprinted from: Bennett, J. P. The treatment of lime-induced chlorosis with iron salts. California Agr. Exp. Sta. Cir. 321:1-12. 1931.

inches deep. In the bottom of each hole is placed a quantity of ground iron salt such as iron citrate (either ferric citrate or ferric oxalate), and the hole is sealed with some kind of wax. Table 4 shows the dosages recommended.

The treatment is not a permanent one, though it will last about three years. Thus far no permanent treatment has been found for this disorder.

Exanthema.[24]—This disease has been found to a limited extent in several counties. Early in the summer—in late May or early June—the very tips of the young shoots turn brown and die, as do also the tips of the terminal shoot leaves. The disease moves downward with the season, so that in severely affected trees three fourths or more of the current season's growth may be dead by the end of the summer. As a result of

[24] Oserkowsky, Jacob, and Harold E. Thomas. Exanthema in pear, and copper deficiency. Plant Physiol. 13:451–67. 1938.

this process, repeated year after year, affected trees become dense and bushy, presenting a sort of witch's broom effect. Copper applied to the trees has been found to be a cure. It may be applied as crystals of copper salts (for example, copper sulfate) introduced directly into a hole bored into the base of the tree; or as a spray of bordeaux mixture. Amounts of copper sulfate as small as one-fourth grain injected into the tree are

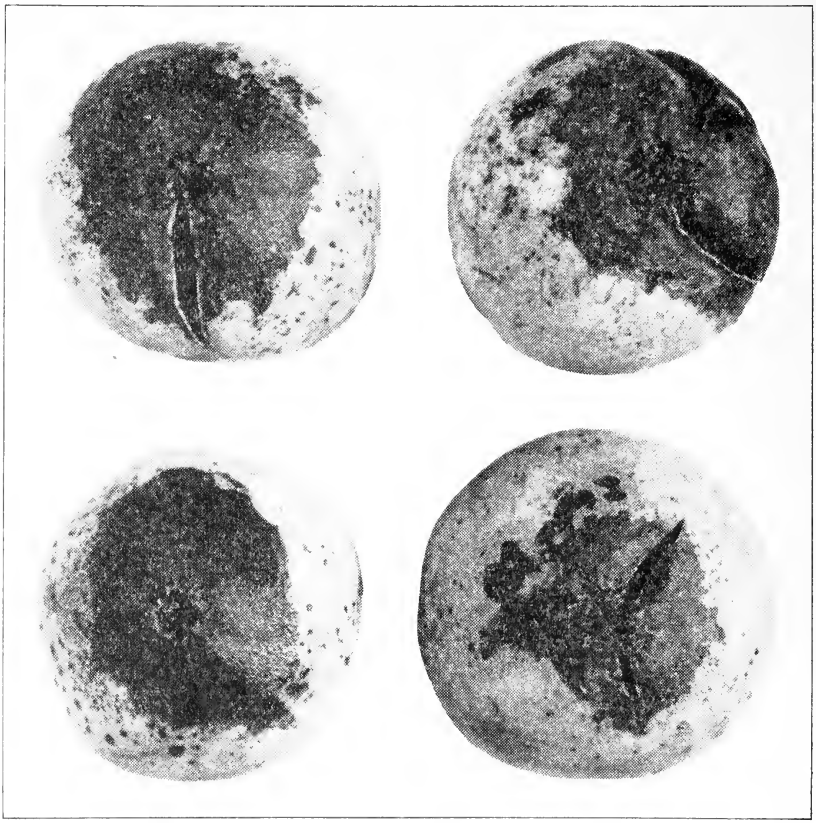

Fig. 30.—Bartlett pears severely affected with black-end.

effective. In the investigations so far reported, these methods have produced better results than the application of copper salts to the soil.

Black-end.—This disease, which affects only the fruit, shows several different types or degrees of damage. In severely affected fruits the flesh of the calyx end will have blackened and frequently will have cracked open (fig. 30). In less severe cases only a small area of the flesh around the calyx lobes or perhaps only the calyx lobes themselves will have blackened (fig. 31). In other instances the blackened areas around the lenticels will be isolated from each other, giving the fruit the appearance of being

Quince roots are more susceptible than any of the pear roots tested.[22] Another root rot, caused by *Dematophora* (*Rosellinia*) *necatrix*, is more destructive to pear trees, killing young trees on French roots within one or two years. The symptoms closely resemble those of the *Armillaria* root rot. Both fungi produce a whitish growth in the bark around the crown of the tree. *Armillaria* is usually distinguishable by fan-shaped mats of the fungus in the bark or between the bark and wood and by black or brown strands on the surface of the bark. In wet soil, *Dematophora* produces a loose cottony growth on the surface of roots and in openings in the soil nearby. Doubtful cases should be submitted to someone familiar with these diseases.

Usually no control is needed for the *Armillaria* root rot in pears on French roots, and at present none is known for the *Dematophora* root rot.

Certain water molds may cause considerable losses in the nursery or soon after transplanting, especially in heavy soil and wet winters. The trunks above the union are often more affected than the crown and roots. Some of the trouble can be avoided by storing nursery stock under cover, by covering only the roots when plants are heeled in, and by planting at normal depth rather than deeper.

Scab.—This disease, caused by the fungus *Venturia pirina*, is much more prevalent in the counties bordering the coast than in the interior. Its severity varies widely, however, from one district to another in the same county and from year to year in the same locality. Varieties differ considerably as to susceptibility, although none of those commonly planted are highly resistant.

Circular dark velvety or sooty spots are formed on young fruits, on leaves, and sometimes on new shoots. During the dry season the fungus is often sloughed off, leaving hard, grayish, russeted spots. In severe cases the fruit is distorted and may crack open.

The pear-scab fungus in California orchards overwinters principally in the fallen leaves of the previous season. Although infections on twigs are not uncommon in spring, in commercial orchards here they almost never survive to the following year. About the time the first green tips appear on the fruit buds, the winter spores begin to be discharged from the fallen leaves and to be carried by air currents to the trees. Ten days to several weeks later the scab spots begin to appear on leaves and young fruits. The summer spores are produced in abundance on these spots and may be washed or spattered by rain to other fruits and leaves. Apparently these spores are not carried to any considerable extent by the wind.

[22] These conclusions are based on the unpublished experiments and observations of Harold E. Thomas, Associate Plant Pathologist in the Experiment Station.

Infection of the fruit and leaves begins during wet periods. Though occasionally a heavy fog may start infection, the most severe outbreaks follow prolonged rainy periods.

An ideal control program would involve complete protection of growing parts during the spring rains. Since, however, accurate weather forecasts for several days in advance are not yet available, an attempt is made to give continuous protection by sprays during the early stages of growth, especially to fruit buds and young fruits. Usually three spray applications will be sufficient: the earliest soon after the first green tips appear in the flower buds; the second as the flower buds separate in the cluster so that the spray can be driven in between them; and the third along with the first codling moth spray as the last of the petals are falling. Of these, the second application is usually the most important in scab control. The third is often advisable, partly because it involves little additional expense. The first may be necessary also if the disease is severe. Where fire blight is a serious problem a weak bordeaux spray (1–1–50), applied when 20 to 50 per cent of the blossoms have opened, may sometimes reduce both scab and blight; but the results with blight have been erratic.

Both lime-sulfur and bordeaux mixture are effective against scab; and since either may cause spray injury, a relatively weak solution is advisable, such as 1 to 50 for liquid lime-sulfur or 3–3–50 bordeaux. Still weaker sprays have been used successfully provided a thorough job was done. Since the combination of lime sulfur and lead arsenate increases the chances of spray injury, the former, if used, should be replaced in the calyx spray with 4 to 6 pounds of wettable sulfur in 100 gallons of water.

Other bacterial and fungus disorders include crown gall, leaf spots, powdery mildew, and rust. These minor diseases of pears seldom require treatment in the orchard.

NONPARASITIC DISEASES AND THEIR CONTROL

Lime-induced Chlorosis.[23]—Pear trees growing in certain sections of the state, especially in parts of the Santa Clara Valley, are affected by a yellowing or chlorosis of the leaves. Since the disorder has been found to be associated with a high lime content of the soil, it has been termed "lime-induced chlorosis." The symptoms usually appear first on the younger portions of the more rapidly growing shoots and may spread to the older parts of the plant. Soils containing an excess of lime usually contain also an abundance of iron, but in a form not readily available to

[23] Bennett, J. P. The treatment of lime-induced chlorosis with iron salts. California Agr. Exp. Sta. Cir. 321:1–12. 1931.

the tree. Excess lime in the soil quickly renders any iron added to the soil insoluble and unavailable. Experiment has shown, however, that iron may be added directly to the trees and the chlorotic condition thus cured.

A satisfactory method of preparing the tree for the introduction of iron is to bore ¼- to 7/16-inch holes in the roots, in the trunk either above or below ground, or in the branches. The holes should be bored at intervals of 3 to 4 inches apart around the root, trunk, or branch, and 1 to 3

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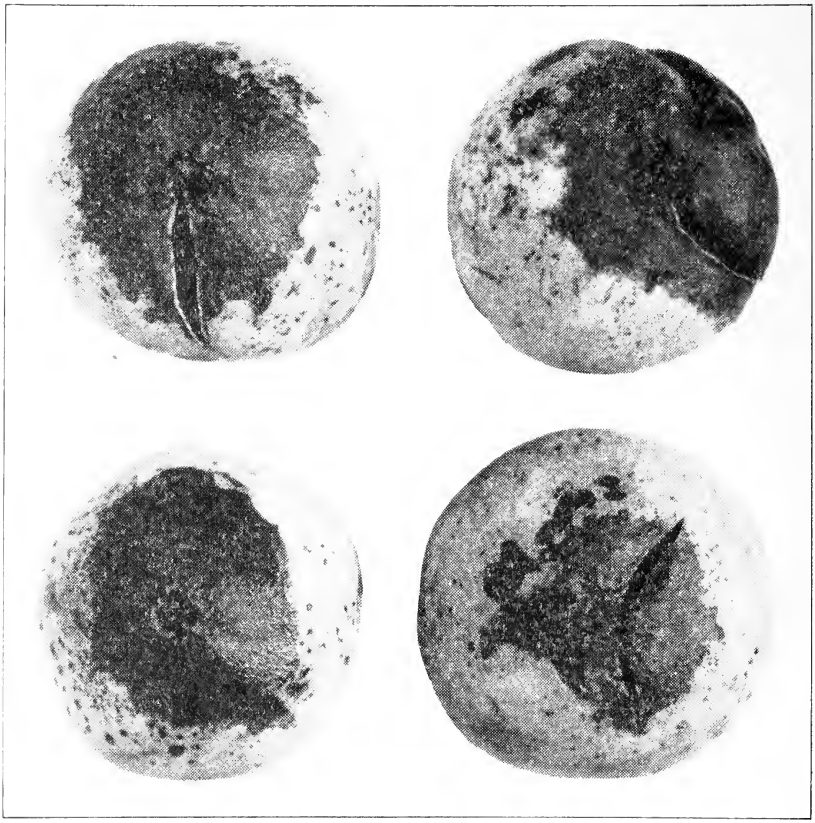

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covered with black dots (fig. 32). Fruits with the latter type of injury have usually a distinctive shape. The calyx, instead of being depressed in the normal way, is prominent and almost protrudes. Specimens of this shape have been termed hard-end fruits. Besides having a prominent calyx they are smooth and rounded as though molded by a giant hand (fig. 33). Not all fruits of the hard-end shape, however, are dotted with black; many have no distinguishing marks except the distinctive shape.

Either hard-end or black-end fruits have little or no commercial

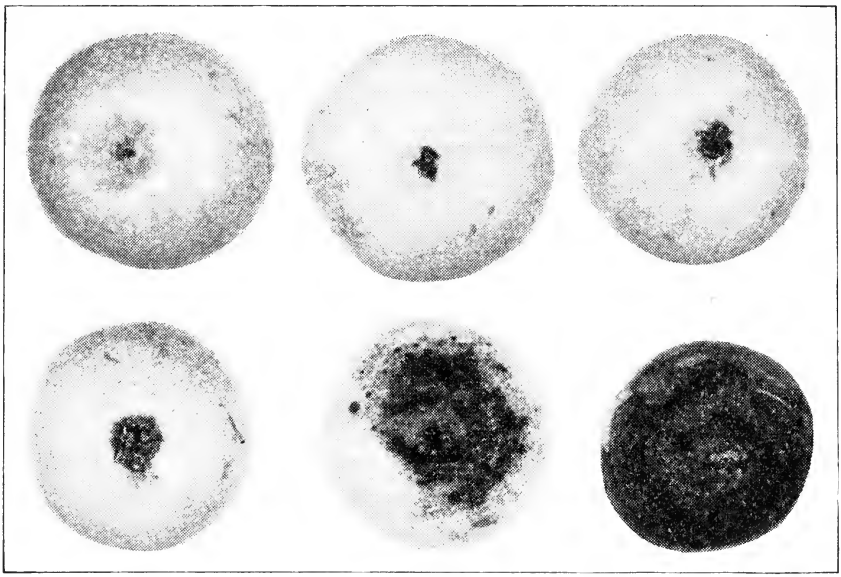

Fig. 31.—Bartlett pears showing varying degrees of severity of black-end. The fruit in the upper left is not affected with the disease.

value. The former fail to soften and ripen normally; the latter are marred by the diseased areas.

The disease has been found only on certain rootstocks. The stock which has the greatest percentage of trees showing black-end and which causes the greatest loss is the Japanese, *Pyrus serotina*. The disease has also been definitely observed on trees growing on *Pyrus ussuriensis, Pyrus betulaefolia,* and Kieffer seedling rootstocks, although a smaller percentage of such trees were producing black-end than of those on *P. serotina*. The disease has been seen also in a block of trees thought to be on *P. calleryana*. Since, however, only a few of these produced black-end, further evidence would be needed to be sure that the rootstock was not a hybrid, one of whose parents was capable of producing black-end. Likewise, black-end has been observed on trees thought to be on French root (*Pyrus communis*); but again the rootstocks might have been hybrids. Only by

leaf characters can species of pear-root stocks be identified; and this method fails when hybrid stocks are encountered.

Many experiments looking toward the cause or cure of black-end have been performed—for example, the addition of a complete fertilizer; the injection of many different elements into the tree; the addition of lime,

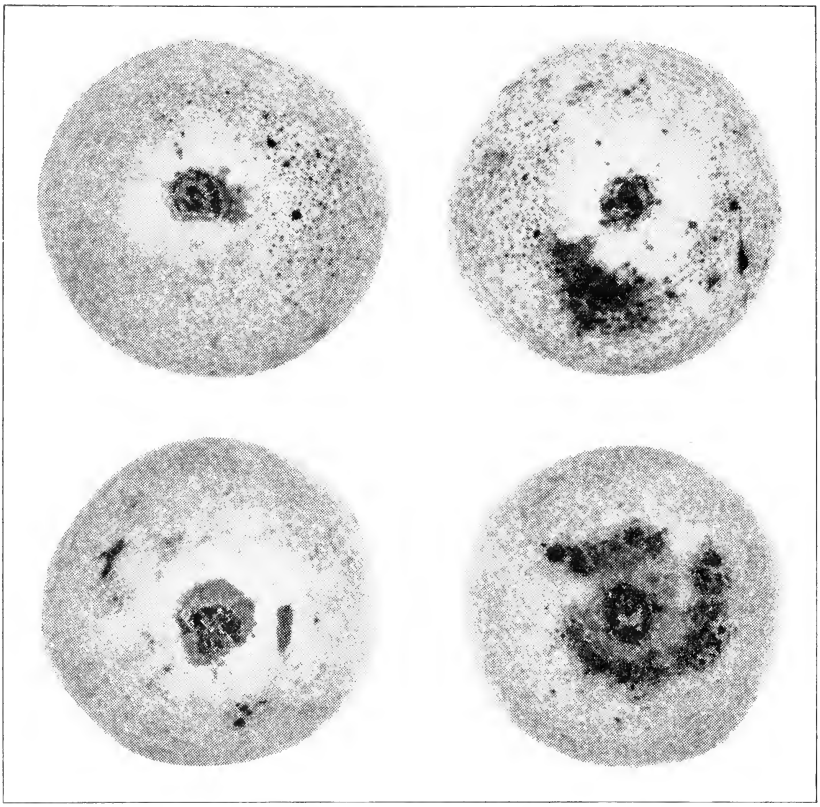

Fig. 32.—Bartlett pears showing varying degrees of black-end in which part of the blackening occurs in isolated areas around the lenticels. The fruits have the distinctive hard-end shape.

sulfur, and manure to the soil; and the inarching of trees with French seedlings. Of these, only inarching has had any effect, and then only when the original rootstock has been severed by sawing or by girdling (fig. 34). Such a procedure has little to recommend it. Many years are required for inarches to reach sufficient size to support the tree before the severing of the original stock. Conceivably, it may be very difficult to prevent decay from entering the tree through the severed stump or dead roots, perhaps causing considerable damage. Finally, as experience has shown, inarched seedlings grow unevenly; the growth of a sufficient

number to give a good distribution of roots around the tree are seldom found.

As shown by records kept on individual trees, the disease does not spread from one tree to another, and the trees maintain their relative order with respect to severity of the disease from year to year. Thus the tree that has the greatest percentage of black-end one year may be expected to have the greatest percentage in any other, although the actual level may vary.

Judging from our present knowledge of black-end, the most feasible

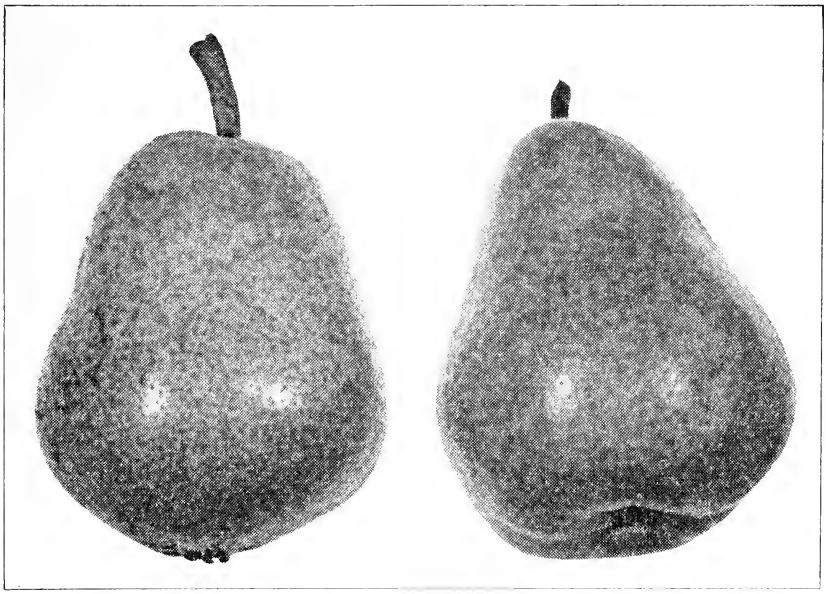

Fig. 33.—Bartlett pears showing the contrast between the shape of the hard-end fruit (left) and a normal-shaped fruit.

procedure for the grower would be to map his orchard carefully at harvest time, marking unprofitable trees and replacing them with trees on rootstocks that do not produce the disease.

Boron Injury.—In some pear districts excess amounts of boron, either introduced in the irrigation water or occurring naturally in the soil, have caused injury. With many other kinds of plants, numerous symptoms such as leaf scorch and killing of the tips of stems make it possible to fix the cause; but with pears, unfortunately, the only effect seems to be a dwarfing of the tree or a reduction in yield, both of which might have numerous other causes. One can usually identify the trouble either by observing symptoms on adjacent plants or by making a soil analysis. The only satisfactory control is the adequate use of water low in boron.

Cork Spot.—The Anjou pear may be affected by dead, brown, corky spots, which may occur directly beneath the skin or may be more deeply seated in the flesh, sometimes developing in the core region. The corky areas occur more frequently near the calyx end than in other portions of the fruit. Investigations in Washington where this problem may be especially severe have shown that there are many conditions of the disease that are similar to black-end. Thus it has been found that the disease occurs on Japanese rootstock (*Pyrus serotina*), that certain trees in an orchard may be affected each year and that the severity of the disease

Fig. 34.—Inarched Bartlett pear trees that have been severed from the original rootstock by sawing or chiseling.

varies from year to year, being most severe in years of light crops. No remedy has so far been found for the disorder.

Short, or Apple-Shaped, Bartlett Pears.—In certain districts rather large proportions of the crop of Bartlett pears are round, with the characteristic neck either lacking or practically lacking. Although such fruits are equal in quality to those normally shaped, certain canners will not accept them since the trade apparently expects a canned pear with a neck. Eventually, it is hoped, round fruits desirable in other respects will be accepted without question; but fruits considerably different in shape from the majority of the lot will always have to be sorted out in order to maintain uniformity, whether they will be canned or packed for use as fresh fruit. Climate is probably the most important factor in-

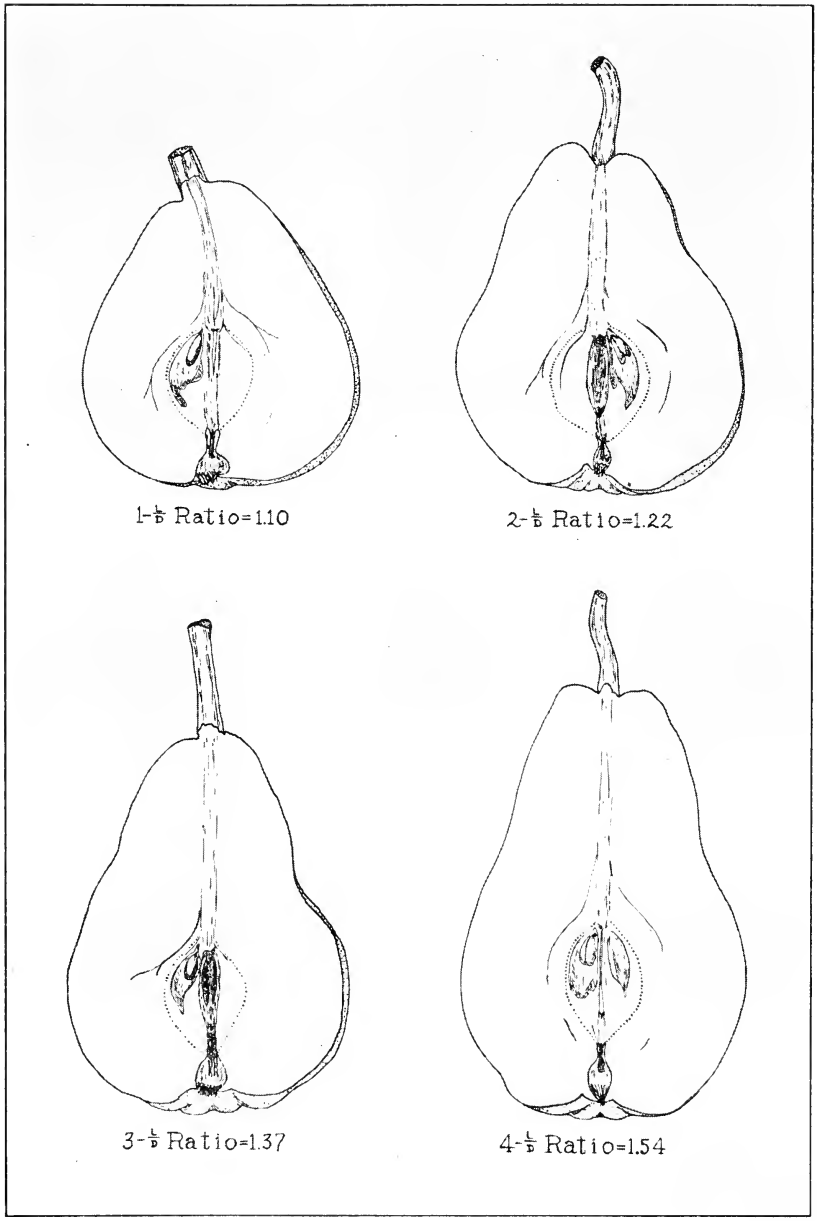

Fig. 35.—Longitudinal sections of Bartlett pears showing length-to-diameter ratios of fruits of various shapes. (From: Amer. Soc. Hort. Sci. Proc. 28:627–33. 1931.)

fluencing the shape of Bartlett pears. The long fruit of the Pacific Northwest is markedly different in shape from that produced in most sections of California. Other factors are of some importance: for example, where

pollinizers are present more seeds occur and the pear is rounder; but since climate is the most important, the grower can do little to control the shape. Figure 35 shows diagrams of fruits of various length-to-diameter ratios.

INSECT PESTS AND THEIR CONTROL[25, 26]

Insect pests on Bartlett and late varieties of pears often constitute a serious production problem. Under our present high standards of shipping inspection, failure to control insect attack often means rejection of the fruit. Control requirements vary with localities; but in many orchards from four to as many as ten spray applications a season are required for control, and this expense may be 25 to 70 per cent of the cost of production. For efficient production of profitable fruit one must understand the insect problems and the standard methods of control. On the following pages, the insect pests of the pear are arranged in the order of their economic importance.

Codling Moth.—The codling moth (*Carpocapsa pomonella*), which occurs wherever apples and pears are grown, causes the greatest losses from insect attack. Only through a properly timed, complete spray program, with careful applications, can these losses be kept at a minimum. Control of the first brood of moths (March to June) is most important and requires rather close timing. The first or calyx spray should be applied when about two thirds of the petals have fallen; and the calyx cups of the fruit must be filled with spray. The second spray should be started 10 to 14 days from the start of the first or calyx spray. For these first two sprays the dosage is as as follows:

Powdered standard lead arsenate	4 pounds
Protein spreader	¼ to ½ pound
Water	100 gallons

Subsequent "cover" sprays are best timed with the codling-moth bait trap[27] records or at intervals not to exceed 15 days during the flight of the moths. For these the dosage should be as follows:

Powdered standard lead arsenate	3 pounds
Protein spreader	¼ to ½ pound
Water	100 gallons

In nearly every pear district one or more sprays must be applied for the second brood of moths (late June to September). Although an appli-

[25] This section was contributed by A. D. Borden, Associate Entomologist in the Experiment Station.

[26] For additional information on insect pests and their control see: Essig, E. O., and W. M. Hoskins. Insects and other pests attacking agricultural crops. California Agr. Ext. Cir. 87:1–155. 1934.

[27] Borden, Arthur D. Codling-moth bait traps. California Agr. Ext. Cir. 63:1–13. 1932. (Out of print.)

cation early in July and another about two weeks later are usually sufficient, more accurate timing may be had by use of bait-trap records. The formula recommended for second-brood sprays is the same as for first-brood cover sprays. Although certain substitutes for lead arsenate have been used in these second-brood applications, they are generally less effective than lead arsenate.

Orchard sanitation, destruction of worms in field lugs, and the steam treatment of overwintering larvae are important auxiliary means of control.

Leafroller.—The fruit-tree leafroller (*Archips argyrospila*), common on many deciduous fruits, may cause serious damage, especially in the coastal areas where it is abundant. It overwinters as an egg mass, and the larvae hatching with the unfurling of the new foliage tie the leaves together to form a nest from which they feed on fruit and foliage. The deep gouges in the young green fruit heal over but leave it misshapen. The best control is a dormant oil[28] emulsion (6 to 7 gallons of oil per 100 gallons dilute spray) applied in January or February to destroy the egg masses. After the larvae are concealed in the rolled leaves, control is very difficult.

Borer.—Larvae of the western flat-headed borer (*Chrysobothris mali*) will work in sunburned areas of the trunks of young pear trees and, if not controlled, may girdle and kill the tree. Recommended measures are the use of tree protectors to prevent sunburn, and the worming-out of the larvae.

Scale Insects.—The widely distributed San Jose scale (*Aspidiotus perniciosus*) is important because it not only may kill parts of the tree but will cause a characteristic pitting and red stain on the fruit. It is readily controlled by thorough applications in January and February of dormant oil emulsion (4 gallons oil per 100 gallons of dilute spray).

Certain soft scales known as mealybug (*Pseudococcus* sp.) infest the limbs, foliage, and fruit. They not only weaken the growth but, when infesting the calyx end of the fruit, cause the characteristic "black drip." In winter, when they are found in all stages in roughened areas and under bark scales, a full dormant spray of the following combination is recommended:

Dormant oil emulsion	5 gallons
Liquid lime-sulfur solution	3 gallons
Water to make	100 gallons

[28] A dormant oil, as the term is used in this text, is an oil of the viscosity of 100–120 seconds Saybolt, and unsulfonated residue of 70 per cent. For method of preparation of oil emulsions by the tank-mixture method see: Borden, Arthur D. Oil sprays for deciduous fruit trees by the tank-mixture method. California Agr. Exp. Sta. Cir. 345:1–16. 1938.

Immature migrating forms in late spring and early summer may be controlled by spraying every few weeks with summer-type[29] oil emulsion, 2 to 3 gallons oil per 100 gallons of dilute spray, with ¾ pint nicotine sulfate added.

The Italian pear scale (*Diaspis piricola*) is one of the more difficult scale insects to control because it often gets under the heavy bark of trunk and main limbs and is therefore difficult to wet. A heavy thorough application of dormant oil emulsion is recommended; the dosage is: 6 gallons oil and 3 pounds caustic soda per 100 gallons of dilute spray.

The oyster-shell scale (*Lepidosaphes ulmi*), which occasionally occurs on pear, is also difficult to control. A full dormant application of oil emulsion (6 gallons oil plus 3 gallons liquid lime-sulfur per 100 gallons of dilute spray) should be followed by summer applications of summer-type emulsion (3 gallons oil plus ¾ pint nicotine sulfate per 100 gallons of dilute spray).

Scale insects of minor importance are the greedy scale, the brown apricot scale, and the black scale, all of which may be controlled with a dormant spray of oil emulsion (3 gallons oil per 100 gallons of dilute spray).

Thrips.—Two species of thrips[30] of major importance on pear often seriously affect the production.

The pear thrips (*Taeniothrips inconsequens*), common in the coastal and Bay Region areas, injures the blossoms, fruit, and young foliage. Attempts to control the adult thrips from the time of the green-tip stage of the bud through the blossoming period are unsatisfactory because of the long emergence period of the insect; but control of the larvae hatching during the petal-fall period or soon after is effective because populations and subsequent attacks may then be controlled. The addition of 5 pounds of ¾ to 1 per cent (0.75 per cent) rotenone spray in the calyx spray of lead arsenate is recommended, or the application of 30 to 40 pounds per acre of a rotenone dust.

The bean thrips (*Heliothrips fasciatus*), which occurs in limited areas of warmer valleys, injures foliage and fruit by scarring and deposit in the summer months. Control is best obtained with pyrethrum extract or rotenone sprays or dusts. Summer-oil emulsion and nicotine sulfate are occasionally employed as a combination spray for second-brood codling-moth and thrips control.

Aphids.—The pear-tree root aphid (*Eriosoma languinosa*), which migrates during the summer from elm trees to live on the roots of the Bart-

[29] A summer-type oil, as the term is used in this text, is an oil of the viscosity of 65 seconds Saybolt and unsulfonated residue of 90 per cent.

[30] Bailey, S. F. Thrips of economic importance in California. California Agr. Exp. Sta. Cir. 346:1–77. 1938.

lett pear, is a serious pest on the European rootstocks planted in heavy adobe soils. Young trees may be killed or severely stunted. Those grafted on Japanese or quince rootstock are less subject to attack. Paradichlorobenzene gives excellent control of infested roots.

Although several other aphids may migrate to pear from other hosts, seldom do they become very serious. Nicotine dust or nicotine sulfate in combination with some other spray will generally control them.

Pear-Blister Mite, or Pear-Bud Mite.—This tiny mite ranks second in importance because it not only blisters the fruit and foliage but actually reduces very appreciably the yield and also the quality of the fruit. It may completely destroy the dormant fruit buds or so injure them that only a few misshapen and russeted fruits will develop.

The logical time for controlling this pest is late summer or early fall just as soon as the fruit is harvested. At that time, in most districts, the mite is migrating from the blistered leaves to the fruit buds of next season. The spray formula is as follows:

Summer-type oil emulsion	2 gallons
Liquid lime-sulfur	5 gallons
Water to make	100 gallons

Another means of reducing the blister-mite population is the formula used in the cluster-bud period for scab control: liquid lime sulfur (2 gallons), wettable sulfur (5 pounds), water (100 gallons). This is probably among the most important sprays in the majority of Bartlett pear orchards.

Mites, or Red Spiders.—Four species of mites may become of economic importance on pear. In certain localities and seasons these may assume major importance by causing partial to complete defoliation, russeting, and injury to the fruit.

The European red mite (*Paratetranychus pilosus*) overwinters in the egg stage, and the nymphs appearing in the spring build up populations that in late May or June will cause severe injury. A dormant oil spray (6 gallons of oil to 100 gallons dilute spray) will destroy most of the eggs although often, in heavy infestations, a subsequent spray is necessary. The addition of 1½ to 2 gallons of summer-type oil emulsion to the second codling-moth spray has proved effective.

The two-spotted mite (*Tetranychus telarius*) overwintering in the ground often assumes serious proportions in June and July, especially during a period of high temperatures, and causes severe foliage and fruit injury. Summer-type oil emulsions (1½ gallons oil per 100 gallons dilute spray), alone or combined with lead arsenate sprays, prove effective but may complicate spray-residue removal problems if much lead arse-

nate is present. Often infestations may be greatly reduced, immediately after harvest, by the following application:

Liquid lime sulfur	1 gallon
Wettable sulfur	5 pounds
Water	100 gallons

The almond-mite (*Bryobia praetiosa*), common on most deciduous fruits, may injure foliage and fruit. The overwintering eggs may be destroyed by a dormant oil emulsion (3 gallons oil per 100 gallons dilute spray) and the adults controlled by sulfur dusting or sprays. The leaf rust mite (*Phyllocoptes oleivorus*), which occasionally severely russets the tender new foliage and the fruit, is readily controlled by sulfur sprays or by oil-nicotine sprays.

CONTROL OF SOME OTHER PESTS[31]

Pocket Gophers.—Methods for control of pocket gophers include (1) trapping, (2) poisoned baits, (3) flooding, (4) gassing, and (5) protection of the gopher's natural enemies, especially the barn owl and the gopher snake. Persistent use of two or more of these methods will eliminate gophers on entire areas. Traps are always useful and effective, not only for individual gophers but also for general use where gophers are abundant. Placing of poisoned baits in burrows is useful when gophers are numerous over a large acreage. When an orchard is irrigated, it is easy to kill the gophers that are flooded out. Gassing is less effective with gophers than other methods but finds some use.

Ground Squirrels.—These animals are controlled chiefly by poison, gas, traps, and shooting. Strychnine-coated grain, used with discretion, reduces ground squirrels during late spring, early summer, and autumn. Gassing is best practiced when the soil is damp. Traps are useful for catching individual squirrels. If squirrels are climbing trees to gather fruit, a metal collar around the trunk of the tree will eliminate this sort of damage.

Rabbits.—Rabbits, sometimes abundant, may damage orchards, especially of young trees, by gnawing the bark and eating young shoots. Hunting, the use of repellent paints or sprays, and exclusion fences are the principal means of protection. Sulfurized oil may burn or kill young trees.

HARVESTING AND HANDLING BARTLETT PEARS[32]

Pears differ from most other deciduous fruits in that they attain their

[31] A fuller discussion of these pests will be found in: Storer, Tracy I. Control of injurious rodents in California. California Agr. Ext. Cir. 79:1–62. (Revised, 1938.)

[32] Because of the differences in the outlets and methods of the handling of Bartlett and the fall and winter pears, they will be discussed separately.

highest quality when removed from the tree before they are fully ripe. Thus they are gathered comparatively "green" after they have developed sufficiently to reach their highest quality by ripening off the tree, but not far enough to impair the quality of the ripened fruit.

Maturity for Picking.[33]—The selection of the proper time to pick pears so as to attain the foregoing conditions is rather difficult. Fundamentally it depends upon the fact that the fruit undergoes continuous physical and chemical changes from day to day, as the fruit develops. Among the more obvious changes as the fruit develops and ripens are an increase in size; a gradual change in color from green to a yellowish-green, followed by a greenish yellow and finally by a yellow; and increases in sugar content, soluble solids, softness, and odorous constituents.

Size is a variable that may depend upon growing conditions; fruits of different sizes may be of the same maturity. Size, therefore, will not always indicate the time when the fruit is mature enough for picking. Among the other variables, those readily measurable are color, softness and soluble solids, which indicate sugar content. These are at present used as a criterion of maturity. Numerous experiments have determined the limits of these variables beyond which fruits will not mature satisfactorily after picking. These also form the basis of the maturity standards contained in the Agricultural Code of California. Color is determined by comparison with a standard color chart: No. 1 is green, No. 2 light green, No. 3 yellowish green, No. 4 yellow. Softness is determined by the amount of pressure, measured in pounds, required to force a rounded plunger $\frac{5}{16}$ inch in diameter into the flesh of the fruit to a depth of $\frac{5}{16}$ inch, after the skin from the areas tested, but little of the underlying flesh, has been removed. The instrument used for this measurement (fig. 36) is known as a pressure tester, and the test as the pressure test. The soluble solids are determined by a refractometer on a portion of the composite sample of juice obtained when the pressure test is made.

The maturity at which the fruit is picked will vary with the purpose. Early pears to be shipped East are usually picked as soon as possible in order to take advantage of the prices for fruit of this season. In this case the grower may pick his fruit when it has met the requirements of the maturity standards of the Agricultural Code with respect to pressure or color or soluble solids. Where earliness is not to be had, the grower may find it more profitable to get increased tonnage by allowing the fruit to remain on the tree for a longer period. Other criteria which have been used are the time when the seeds begin to turn brown or when the fruit parts readily from the stem when it is raised.

[33] Allen, F. W. Maturity standards for harvesting Bartlett pears for eastern shipment. California Agr. Exp. Sta. Bul. 470:1–27. 1929.

Picking Size.—Besides the criteria just discussed, relative to the proper maturity for picking, pears are picked according to size. The size is determined by the greatest cross diameter of the fruit and, in practice, by whether a fruit will or will not slip through a ring of a given diameter. The actual size at which fruit is picked depends upon the

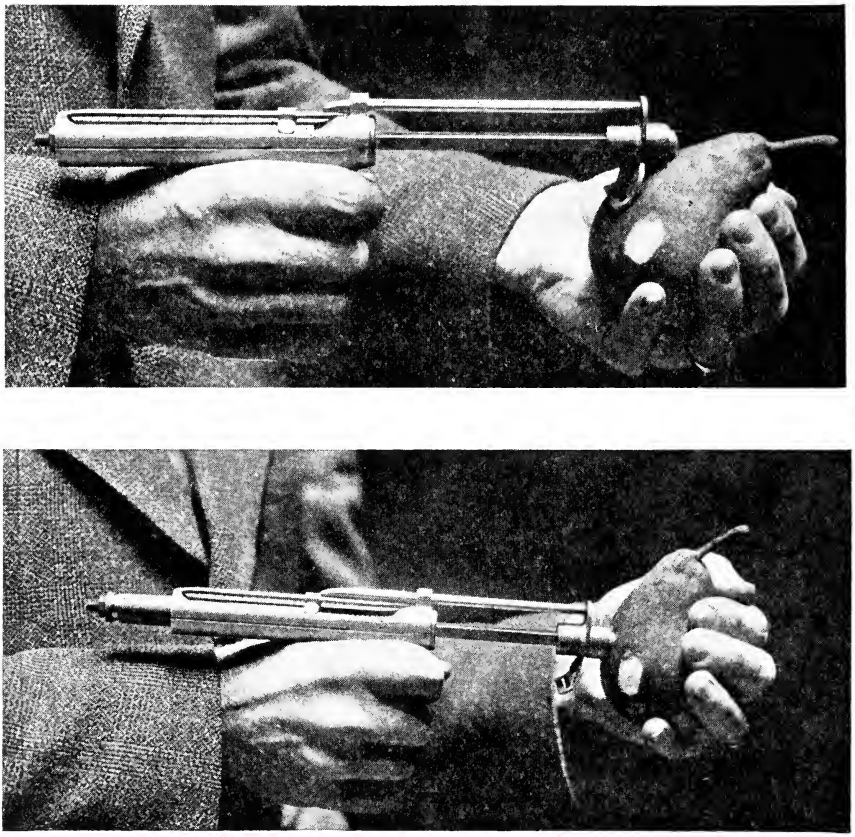

Fig. 36.—California pistol-grip tester. Upper, removing the peel from the fruit. Lower, making the test and taking the reading. (From Bul. 470.)

choice of the grower, the buyer or shipper, or upon an agreement of growers and shippers. By one agreement, covering Bartlett pears, fruit less than 2⅜ inches in diameter and packing more than 180 fruits to the box was not to be marketed. As a rule Bartlett fruits less than 2¼ inches in diameter are considered too small to harvest.

Pear trees that are used to supply fresh fruit are usually picked over three to five times. The fruit is sized by a ring, which each picker carries, or by eye; and all those above a given size are harvested. Being tender

and easily bruised, they should be handled carefully when placed in the picking bucket or bag, when transferred from the picking receptacle to the field lug, and when hauled from the orchard.

Spray-Residue Removal.[34]—Governmental regulations require the removal of certain spray residues on the fruit so that they fall below a given amount per pound of fruit. At present there are rules governing the amount of lead, arsenic, and fluorine allowed. Any amount exceeding these tolerances must be removed before the fruit can enter commercial channels. The limits for each of these materials have varied from time to time, and can best be learned from the agricultural commissioner.

Washing has proved to be the most effective way of removing spray residues. The ease or difficulty of removal depends on several factors. First among these is the amount of residue which has accumulated. In climates like that of California, where little or no rain falls during the growing season, the residue may be relatively large where a number of sprays have been applied. The use of adhesive spreaders and late oil sprays in conjunction with lead arsenate will increase the difficulty of residue removal. Finally, the variety may be a factor, pears with a waxy coating being more difficult to clean than those less waxy.

The most common wash used in California the past few seasons, provided spreaders or oils do not complicate the problem, has been a 1 per cent hydrochloric acid wash (3 gallons of commercial hydrochloric acid to 100 gallons of water) at ordinary temperatures. Although greater concentrations of acid are generally more efficient in spray-residue removal, those greater than 1.5 per cent (5 gallons per hundred) are not advisable because of danger that the acid may burn the fruit. If the acid wash is not sufficiently effective in lowering the spray residue, one may need additional aids such as mineral oil, detergents, or a higher temperature of the wash solution.

Since the problem of residue removal is so closely associated with the spray program, operators in the larger packing-houses, where many lots of fruit are received, may be obliged to treat each lot according to its particular need.

Grading.—Upon delivery at the packing-house the fruit is first run through a bath to remove the residue, then through a rinse water and an air blast to dry before delivery to the sorting table. Here the defective fruit is removed by hand and placed either in a lower grade or among the culls. The fruit of the highest and lower grades is then mechanically sorted to size. Of the several sizing devices used, the most common is one in which the fruit is carried along endless diverging belts. Pears of the smallest diameter slip through and fall into the bins nearest the sorting

[34] Cox, Alvin, Jr. Removal of difficult spray residues. Blue Anchor 15(8):11. 1938.

table; larger fruits into the bins farther down the line. The bins are so placed in relation to the divergence of the belt that one may secure a close approximation of a given number per box by packing directly from a bin without further sorting. The Agricultural Code of California provides that pears packed in any container shall be uniform in size. For pears 2¾ inches in diameter or larger, this means a variation of not more than ½ inch in diameter (measured through the widest portion of the cross section) between the fruits in a container; and for pears smaller than 2¾ inches in diameter, a variation of not more than ⅜ inch.

Most of the pears are packed in one of four packages: the standard pear box, the standard half-box, the export half-box, and the Los Angeles lug. All those packed for interstate or export shipment are individually wrapped in tissue and packed in the standard pear box, half-box, or export half-box. The fruit is further protected by liners around the sides and ends and by pads on the bottom and underneath the top cover. Pears sold within the state are frequently packed unwrapped in the Los Angeles lug.

The standard pear box does not vary in measurement to accommodate the various sizes of fruit, as is the case with many other types of fruit packages. It is 8½ inches deep, 11½ inches wide, and 18 inches long, inside measurements. The approximate gross weight is 53 to 55 pounds; the approximate net weight, 47 to 49 pounds. The standard half-box has the same dimensions as the standard pear box except in depth, which is 4½ inches inside. The approximate gross weight is 26 pounds; the approximate net weight 22 to 23 pounds. The standard export half-box differs from the standard half-box only in being 1 inch deeper. This package, used for export trade only, has an approximate gross weight of 28 pounds, an approximate net weight of 25 pounds.

Pear Packing.[35]—When the fruit has been sized, each packer handles only one size. The empty box is placed on the platform or stand. The packer selects a pear and starts to wrap it (fig. 37, *a*). With his right hand he picks up a pear of the proper size; with his left, at the same time, a sheet of wrapping paper. He should grasp the paper toward one corner to allow more of it to be finally folded over the pear (fig. 37, *b*). The pear is thrown from the right hand into the paper held in the palm of the left hand with the stem up, resting between the thumb and forefinger (fig. 37, *c*). A little force is necessary to break down the paper and bring the corners into position for wrapping with the least amount of lost motion. The corners of the paper are then folded over the apex end of the pear, and the pear is turned up with the right hand, while the left hand and

[35] This section taken from: Duruz, Willis P. Harvesting and handling California pears for eastern shipment. California Agr. Exp. Sta. Cir. 240:1–19. 1922. (Out of print.)

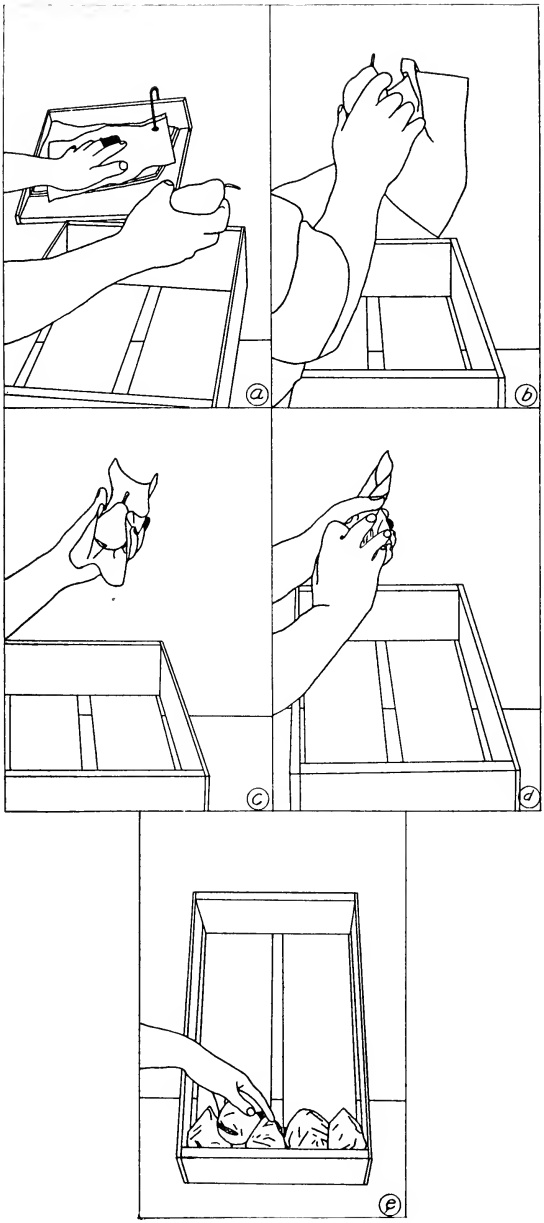

Fig. 37.—Progressive steps in wrapping pears.
(From Cir. 240.)

fingers twist the paper around the stem of the fruit to form a point or cornucopia (fig. 37, *d*). Next, the pear is placed in the box with the left hand, the stem pointing toward the packer (fig. 37, *e*), except that in the first row across the end of the box, the stem points in the opposite direction. While the wrapped pear is being placed in the box with the left hand, the right hand is reaching for another.

The question may arise as to the additional time required in wrapping

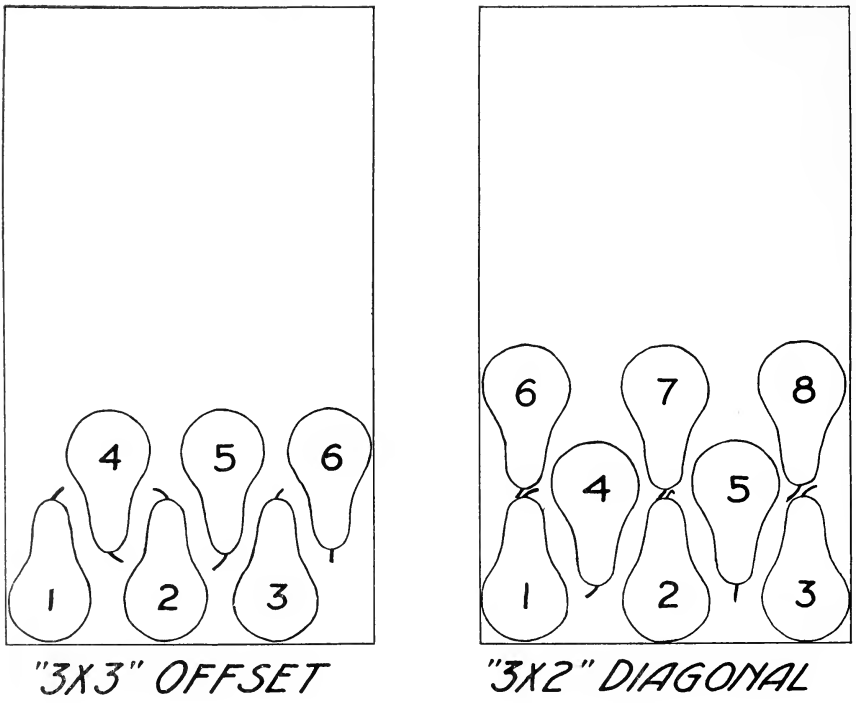

Fig. 38.—Styles of pear packs. (From Cir. 240.)

each fruit. As a matter of fact, packing can be done much faster with wrapping than without. The actual time of wrapping is but a fraction of the total time involved in the operation of packing. If packed without wrapping, the pears will often not remain in place well, whereas if wrapped they will "stay put."

Styles of Pack.—There are two styles of packs, the "offset" and the "diagonal." The "offset" (3×3) is employed for pears of a size that will give five or more across the box. For pears larger than this the "diagonal" pack (3×2) should be used.

"Offset" (3×3) style: The first pear is placed in the left-hand corner of the box; the next two are so placed that the space between the first

and second and between the second and third will be the same as that between the lower right-hand corner and the third pear. This row is placed with the stem pointing away from the packer. The next row is placed with the stems toward the packer, the pears nesting in the spaces formed by the first three pears (fig. 38). This system is continued throughout the first layer, with the stems pointing toward the packer, care being

Fig. 39.—Standard box of pears. This box does not vary in measurement to accommodate the various sizes of fruit as do many other types of fruit packages; the number of individual fruits in a box varies according to their size. The package measures 8½ inches in depth, 11½ inches in width, and 18 inches in length, inside. The approximate gross weight is 53 to 55 pounds; approximate net weight 47 to 49 pounds. (Courtesy, California Fruit Exchange.)

taken to keep the alignment perfect. In starting the second layer, packing should begin in the opposite corner of the box, and the pears should be placed directly over the spaces formed by the fruits in the first layer.

"Diagonal" (3 × 2) style: This pack resembles the "offset" style except that it is started by placing one pear in each corner of the box and a third pear midway between them. The next row is placed in the spaces formed by these three (fig. 38). The pack is continued as for the "offset" style.

One important consideration is securing a proper bulge (fig. 39) to

the completed pack. This is learned with a little practice. The building of the bulge should begin with the first layer. In the middle of each layer the fruit should be slightly larger or should have the stems pointing at a slightly steeper angle upward than the pears in the end. This system is continued throughout the box so that when the top is reached there will be a bulge of 1½ to 3 inches at the center of the box above the fruit at the ends, which is level.

This bulge is necessary for a solid pack. Pears will shrink considerably in transit. If packed loose they will soon be disarranged and will shake around in the box with resultant bruising and rapid decay.

The packed box must be marked with the total number of pears con-

TABLE 5

THE VARIOUS PACKS IN THE STANDARD CALIFORNIA PEAR BOX

Number of fruits in box	Style of pack	Number of fruits in row	Layers deep
70	2 × 3 diagonal	3 × 4	4
80	2 × 3 diagonal	4 × 4	4
90	2 × 3 diagonal	4 × 5	4
100	2 × 3 diagonal	5 × 5	4
110	2 × 3 diagonal	5 × 5	4
120	3 × 3 offset	4 × 4	5
135	3 × 3 offset	4 × 5	5
150	3 × 3 offset	5 × 5	5
165	3 × 3 offset	5 × 6	5
180	3 × 3 offset	6 × 6	5
195	3 × 3 offset	6 × 7	5
210	3 × 4 diagonal	6 × 6	5
228	3 × 4 diagonal	6 × 7	5
245	3 × 4 diagonal	7 × 7	5

tained, which can readily be determined by referring to table 5. By counting the number of pears across the box and also the number lengthwise in two consecutive rows, one can find the total number of pears by means of the table.

Precooling.[36]—In the past few years, an increasing number of pears have been precooled before shipment. Precooling is a form of refrigeration that rapidly removes the field heat from the pears before shipping, chiefly to reduce the temperature to a point where ripening will be materially arrested.

Precooling may be done either before or after loading in refrigerator

[36] Allen, F. W., and L. R. McKinnon. Precooling investigations with deciduous fruits. California Agr. Exp. Sta. Bul. 590:1–142. 1934.

Allen, F. W. An experimental test trip with precooled Bartlett pears. Blue Anchor 12(11):1–11. 1935.

Claypool, L. L. A test trip to New York with Sacramento River Bartlett pears. Blue Anchor 14(11):15–23. 1937.

cars. In the former case the cooling is done by storing the fruit in a warehouse under mechanical refrigeration. When precooled in the refrigerator cars, either mechanical refrigeration may be used by blowing cold air through the car, or ice stored in the bunkers may serve as a refrigerant. In this last case, salt is generally employed to lower the temperature, and some form of blower to circulate the air.

Precooling not only reduces the rate of ripening but also permits cars to be shipped East without re-icing in transit, or, in very hot weather, with perhaps one re-icing. A saving in transportation costs is consequently accomplished.

Waxing.[37]—Recent investigations have shown that pears may be kept longer when covered with certain waxes. Much experimental work must yet be done, however, before the limitations and adaptabilities of these materials are known.

Pears for Canning.—Pears for canning are usually picked at a lower pressure test than pears used for fresh fruit. They attain an average size larger than that shipped, and fewer pickings are made.

Canners usually specify the range of sizes, the grade, and the ratio of length to diameter of fruit which they will accept from the grower. The length-to-diameter ratio specified varies somewhat with the district in which the fruit is grown. Thus a greater ratio is demanded for pears from the Pacific Northwest than for pears from California. Fruit is bought by the ton, the price varying with the year and district. Certain areas which the canners believe produce a superior canned product receive a premium.

If the cannery is not processing other fruits at the time of delivery, the pears are placed in large ripening rooms of controlled temperatures and humidity. The fruit is sorted frequently in order to process it at the proper stage of ripeness. If the cannery cannot process the fruit at the time of delivery, it is first placed in cold storage and later removed to the ripening rooms.

Dried Pears.—Although the proportion of pears dried is not large, this phase of the industry does offer an outlet for an appreciable tonnage. Pears for drying are ripened by allowing them to stand in the lug boxes in a shed or shade and by sorting out the fruit as it ripens. Dried pears are produced from fruit sorted out of that being shipped and from fruit grown primarily for drying. In the latter case the pears are allowed to remain on the tree longer than for fresh shipment in order to attain greater size.

Pears for drying must have the spray residue removed before ripening. When they are cut, the calyx end is removed, the fruit separated

[37] Claypool, L. L. The waxing of fruit. Blue Anchar 16(4):6–8. April, 1939.

into two equal halves, and the stem cut out or pulled out. The core is ordinarily not removed. The fruit is then spread on trays, cut surface up. Sulfuring pears requires a long time, varying from 6 to 72 hours, as contrasted with 2 to 4 hours for apricots. In Lake County, where many pears are dried, they are sulfured 24 to 72 hours. The longer sulfuring gives the desired translucency. To attain the best color, pears should be exposed to direct sunlight for only ½ to 2 days, after which the trays are stagger-stacked. Two to four weeks are usually required to complete the drying.

HANDLING AND STORING FALL AND WINTER PEARS[38]

The principal fall and winter varieties grown in California are the Hardy, Anjou, Comice, Bosc, Winter Nelis, Glou Morceau, and Easter. All these are used for fresh fruit. Picking and packing are like that for the Bartlett. In the fall and winter varieties the highest quality is attained by storing and ripening under carefully controlled conditions of temperature and humidity. Since such conditions are not always readily available, an increasingly common practice is to store the fall and winter varieties in rooms at 30° to 31° Fahrenheit, removing them as the trade demands and ripening them in special rooms between 60° and 70° with the humidity well controlled, before delivery to the retailer. This insures the maximum quality for the consumer. Such ripening rooms are now available in many of the eastern terminal markets.

Maximum quality can be attained not only by observing the proper conditions of storage and ripening but also by exercising a proper knowledge of the limitations of each variety with respect to its storage life. The Bosc, for example, is at its best from September 1 to December 15 and should never be held beyond the Christmas holidays. It should be held constantly at 30° to 31° Fahrenheit, and after cold storage it must be ripened at 60° to 70°. It will not ripen in cold storage and will lose its ability to ripen if held for any length of time at temperatures between 34° and 35°.

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[38] Allen, F. W. The harvesting and handling of fall and winter pears. California Agr. Exp. Sta. Bul. 533:1–46. 1932.

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